Appendix P. Klamath Network Data Management Plan, *Draft*.

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Acknowledgements

Prior to developing this document, 17 NPS Inventory and Monitoring Networks had completed or were in the final stages of completing data management plans. Much of the material in this plan was developed from information and insight provided by Data Managers in those networks. It is difficult to give credit to specific individuals because of the significant amount of collaboration that went into developing those plans. The Klamath Network would like to thank all participants in those 17 networks whose work was valuable in developing our Data Management Plan. Specifically, five data management plans were used extensively in the development of our plan and we would like to send our appreciation to the authors of those plans: John Boetsch, Bret Christoe, and Ronald Holmes (North Coast and Cascades Network), Rob Daley (Greater Yellowstone Network), Dorothy Mortenson (Southwest Alaska Network), Nicole Tancreto (Southern Colorado Plateau Network), and Doug Wilder (Central Alaska Network). The organization, detail, and content of these Data Management Plans were commendable and greatly helpful. In addition, we would like to give thanks to the former Klamath Network Data Manager Robert Truitt (Mojave Network). We appreciate the ground work you laid to help us outline and complete our data management plan. Finally, I want to give thanks to Park and Network staff who spent valuable time reviewing and editing this document. For this effort our thanks goes out to: Laura Bridy and Elizabeth Perry.

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Executive Summary

The overall mission of the U.S. National Park Service is to conserve natural resources in a manner that leaves them unimpaired for future generations. To help meet this goal, park managers need to have the most up-to-date scientific information available about the status and trends of natural resources within the parks. The interactions among natural resources create a complex ecosystem that is difficult to track and monitor. Abiotic, biotic, and dynamic influences that span spatial and temporal scales make it complicated to predict the overall effect that activities within and outside the parks may be having on those resources. The overriding objective of the Inventory and Monitoring Program is to select key resources within the parks and monitor those resources to make available status and trend information to park managers. Providing high quality information about natural resources will help park managers obtain their goals and support the overall mission of the National Park Service.

A solid and comprehensive data management program that takes into account the complexities of long-term natural resource monitoring is essential to accession, storage, and dissemination of quality information to support the management of park ecosystems. The main objective of the Klamath Inventory and Monitoring Network's ("Klamath Network" or "the Network") Data Management Program is to incorporate practical and sound data management methods into the Network's projects so we can provide quality information over time. Long-term data management must take into account changing technology, developing field methodologies, and most importantly, turnover in personnel. Developing a data management program where every employee understands the roles and responsibilities they have towards data management throughout all phases of a project is essential to obtaining quality information. We developed the Klamath Network Data Management Plan to provide guidance on how data and information will be managed over an infinite amount of time. The overall goals of this Data Management Plan are to ensure:

- Every individual working for the Network understands his or her responsibilities towards data management.
- Data managed by the Network is of high quality, easily accessible, understandable, and secure not only for the duration of a project, but also for future generations that may utilize the information.
- Direction is provided on integrating proper data management practices throughout all phases of a short or long-term project from planning through archiving.
- Collaboration will occur at all levels of the agency and with external cooperators on data management issues.

The Klamath Network Data Management Plan is not intended to be a detailed data management document, but more of an outline that gives the reader general

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direction on how to manage data for the Network. The Klamath Network will utilize the Data Management Plan, standard operating procedures, protocols, and guidance documents to report how the Network will produce natural resource information that is accessible, secure, and of high quality over time. This document describes:

- The goals and objectives of the Klamath Network Data Management Program.
- The roles and responsibilities each member of the Network has towards data management throughout each phase of a project.
- How Klamath Network personnel will prioritize our time and funding towards data management activities based on information needs outlined in monitoring protocols and inventory projects.
- Details of the infrastructure the Network will utilize to create, store, maintain, and disseminate data and information.
- The methods the Klamath Network will follow to manage data throughout all phases of the data lifecycle.

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1. Introduction

Since 1916, the mission of the U.S. National Park Service (NPS) has been "…to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (National Park Service Organic Act, 1918).

Chapter 4 of the 2006 NPS Management Policies states, "The National Park Service will strive to understand, maintain, restore, and protect the inherent integrity of the natural resources, process, systems, and values of the parks." This policy, 90 years after the Organic Act, continues to stress that one of park managers' core responsibilities is to preserve park resources, and their associated values, in their natural state for future generations. Through a well maintained data management program, inventories of park- related natural resource data, and a long-term natural resource monitoring program, the Klamath Inventory and Monitoring Network ("Klamath Network" or "the Network") can provide park managers with up-to-date scientific knowledge and tools to help them better understand and manage the parks' ecosystems. The objective of this Data Management Plan (DMP) is to provide a guideline that the Klamath Network will follow in order to manage all aspects of ecological data maintained by the Network.

1.1 The Inventory and Monitoring Program

In 1998, the National Parks Omnibus Management Act created a framework for the Inventory and Monitoring Program which fully integrates natural resource monitoring and other scientific activities into the management process of the National Park System. Section 5934 of the Act requires the Secretary of the Interior to develop a program that establishes baseline data and long-term trend information on the condition of natural resources within the parks.

To carry out this mission, the NPS Inventory and Monitoring (I&M) Program was developed to provide support and funding to approximately 270 National Park units by conducting inventories and long-term monitoring of natural resources. The 270 park units have been divided into 32 "vital sign" networks of similar geography, natural resources, and resource protection challenges. Each network has been tasked with documenting existing park vertebrates and vascular plants, developing and implementing a vital signs monitoring program, and preparing a detailed data management plan.

The long-term objectives of the I&M Program are to:

- Inventory the natural resources and park ecosystems under NPS stewardship to determine their nature and status.
- Monitor park ecosystems to better understand their dynamic nature and condition and to provide reference points for comparisons with other, altered environments.
- Establish natural resource inventory and monitoring as a standard practice throughout the NPS that transcends traditional program, activity, and funding boundaries.
- Integrate natural resource inventory and monitoring information into NPS planning, management, and decision making.

- Share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives.

1.2 The Klamath Network

The Klamath Network encompasses six park units managed by the NPS in northern California and southern Oregon. Collectively, these six units comprise nearly 200,000 hectares and range considerably in size and elevation (Table 1). The parks within the Network span a region of complex topography that can be split from north to south into two geologically distinct subregions, the Klamath-Siskiyou (KS) and the Cascades-Modoc (CM) subregions. The Klamath-Siskiyou subregion extends eastward from California 0.5 km (0.25 mi) offshore in the Pacific Ocean to the edge of the Cascades foothills. The Cascades-Modoc subregion continues eastward into the Great Basin (Figure 1). The ecosystems of the Klamath Network are maintained by a complex biophysical environment composed of abiotic processes (climate, geology, and ocean characteristics), biotic processes (competition and predation), and temporal dynamics (disturbances) that span multiple spatial and temporal scales (Odion et al. 2005).

Table 1. National Park Service units in the Klamath Network and their size, elevations above sea level, and subregional location.

Park Unit	Size (ha/acres)	Elevation (m)	Subregion
Crater Lake National Park	73,775 / 182,298	1219-2720	CM
Lassen Volcanic National Park	43,047 / 106,369	1585-3187	CM
Lava Beds National Monument	18,898 / 46,697	1200-1685	CM
Oregon Caves National Monument	196 / 484	1122-1670	KS
Redwood National Park	42,700 / 105,469	0-996*	KS
Whiskeytown National Recreation Area	17,614 / 43,524	244-1893	KS

*The subtidal zone at Redwood National Park extends 0.5 km offshore to an unknown depth below mean sea level.

The USDA Forest Service and USDI Bureau of Land Management have jurisdiction over most lands bordering park units. There are also a number of other agencies and non-profit groups managing and protecting lands within the Klamath region, such as the California Department of Fish and Game (CDFG), The Nature Conservancy (TNC) and Oregon Department of Fish and Wildlife (ODFW). To efficiently use all resources available to the Klamath Network, interagency collaboration is essential.

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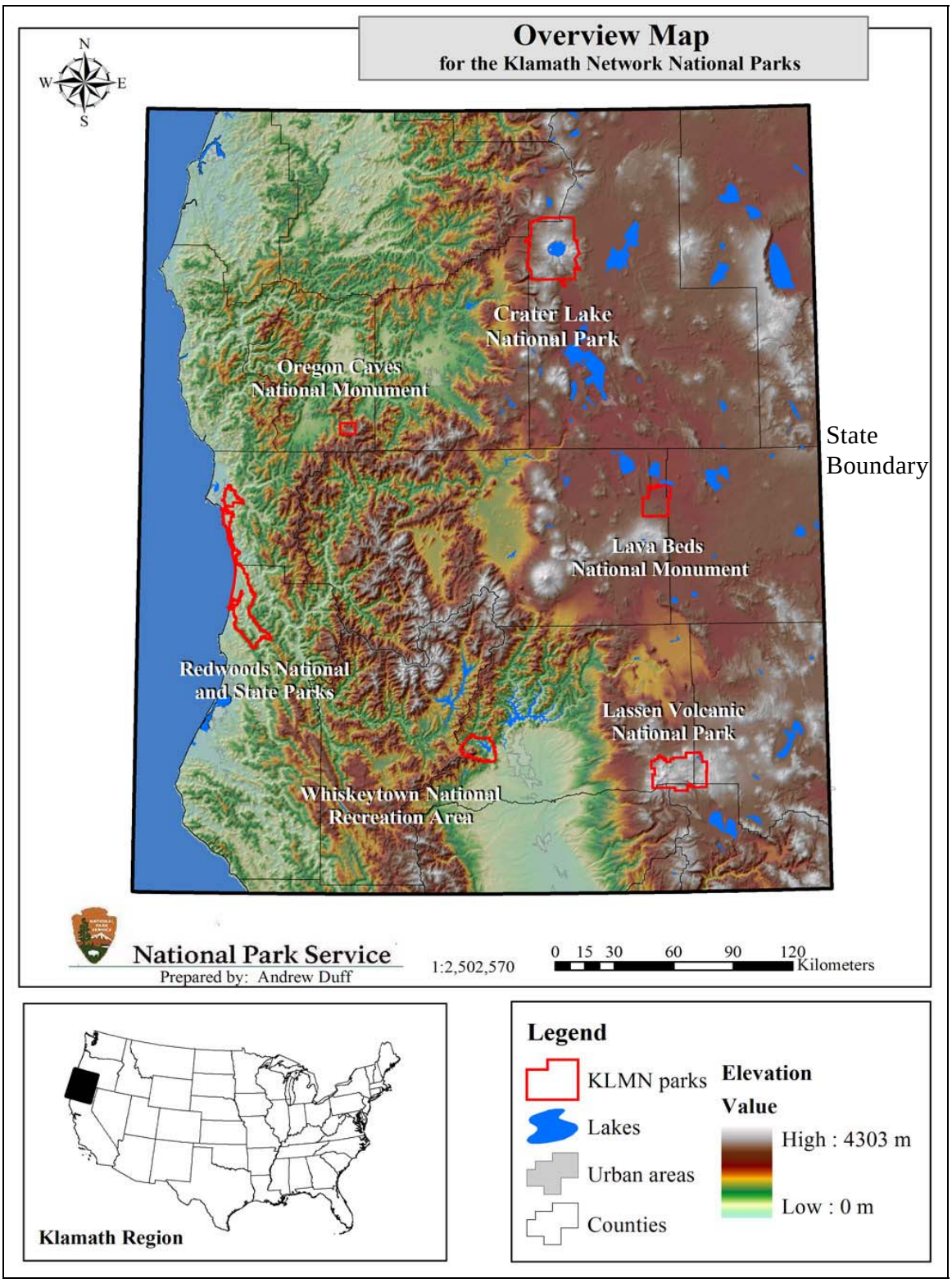

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Figure 1. National Park units in southern Oregon and northern California that comprise the Klamath Inventory and Monitoring Network.

1.2.1 Network Staff

The Klamath Network headquarters are located on the campus of Southern Oregon University (SOU) in Ashland, Oregon. Four positions compose the "core staff" of the Klamath Network, including three technical professionals, the Network Coordinator, Data Manager, and Aquatic Ecologist, and the Program Assistant, who plays a support role for all three (Figure 2). The three technical professional staff positions share responsibility for vital signs planning and, together with affiliated park staff and cooperators, will implement the program. The staffing structure has been designed around the expertise requirements necessary to design, execute, evaluate, and report a vital signs monitoring program that encompassed terrestrial, subterranean, freshwater, and marine ecosystems. The projected operational staff for the Klamath Network is shown in Table 2. In addition, the Board of Directors, Technical Advisory Committee, and Subject Expert Workgroups help provide guidance and support to the program.

Table 2. The projected Klamath Network personnel structure, position type, and pay scale.

Position	Position Type	GS Level
Network Coordinator*	NPS Permanent	GS - 12
Network Data Manager*	NPS Permanent	GS - 11
Aquatic Ecologist	NPS Term	GS - 11
Program Management Assistant	NPS Term	GS - 07
Project Crew Leader (3)	NPS Term	GS - 07
Project Crew Members(7)	NPS Seasonal	GS - 05
GIS Specialist*	Contract / Agreement	NA
Statistician or Biometrician*	Contract / Agreement	NA

*Staff currently working for the Klamath Network as of December 15, 2006.

1.2.2 The Board of Directors

The Network's oversight is provided by the Board of Directors, consisting of the Superintendents from the six Network park units, two Resource Chiefs on an annual rotation, and the Coordinator of the Pacific Northwest Region Cooperative Ecosystem Studies Unit. The Pacific West Region I&M Coordinator and the Network Coordinator are ex officio members of the Board. The Board of Directors is chaired by one of the six Superintendents; a term as chairperson lasts two years. Every Superintendent must serve a term before any are eligible to serve a second term.

1.2.3 Technical Advisory Committee

The Network's Technical Advisory Committee is made up of the six Resource Chiefs, the Network Coordinator, and the Network Data Manager. The Technical Advisory Committee coordinates the Klamath Network activities and provides decision points to the Board of Directors. In addition, the Technical Advisory Committee imparts guidance to the Subject Expert Workgroup. The Network Coordinator is responsible for convening regular meetings and inviting other park staff, partners, and contributors as dictated by the meeting agenda.

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1.2.4 Subject Expert Workgroup

The Subject Expert Workgroups are composed of subject experts and interested personnel that provide advice to the Technical Advisory Committee. The groups are primarily composed of personnel selected from the Network parks, allied agencies in the area, and neighboring university faculty.

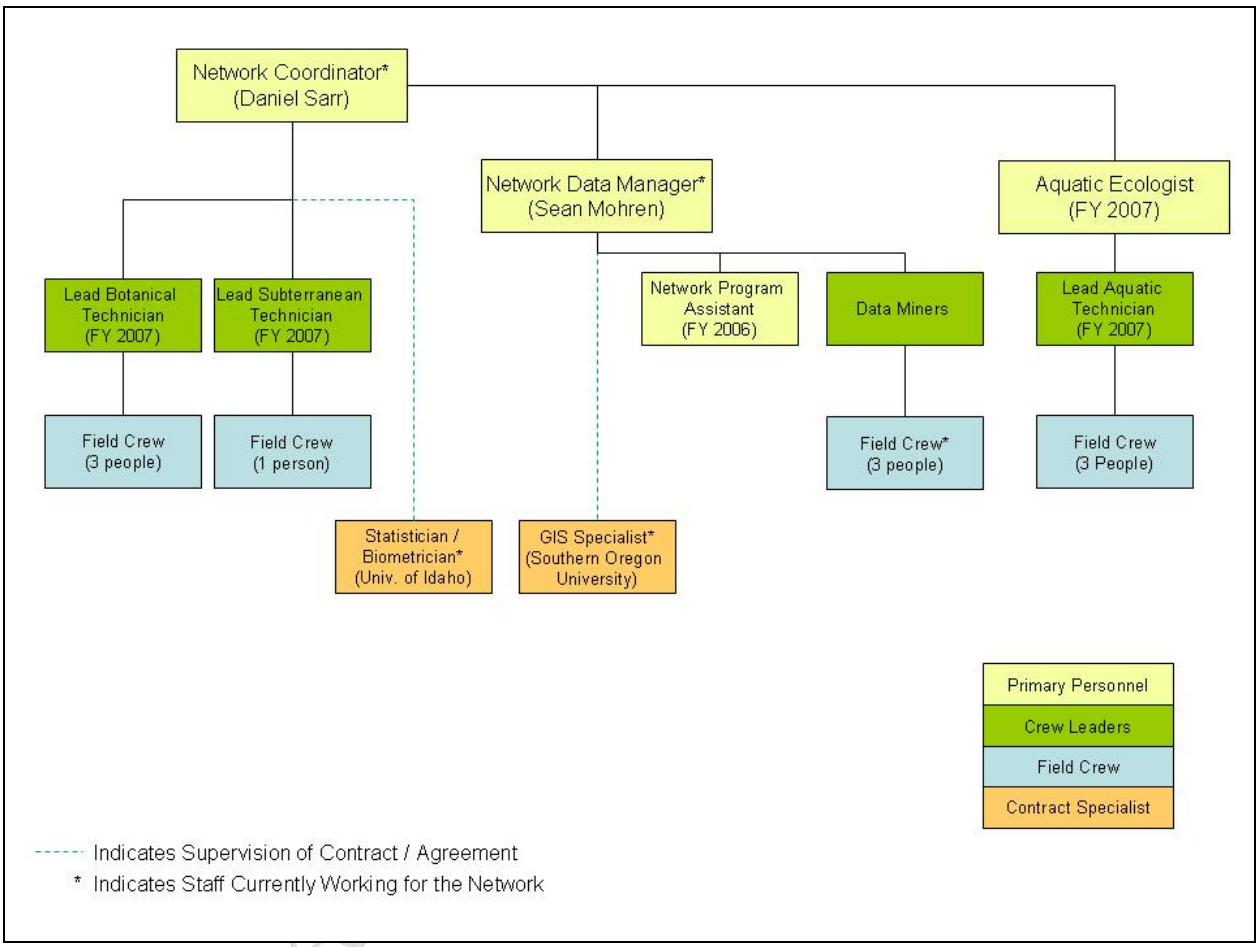

Figure 2. The projected personnel structure for the Klamath Inventory and Monitoring Network.

1.3 Scope and Objective of the Data Management Plan

The Data Management Plan is a comprehensive document outlining the processes and guidelines the Klamath Network will follow to provide high quality, useable natural resource information over time. This plan is a critical first step in designing a sustainable Klamath Network Data Management Program. The Data Management Plan describes the processes used to manage data during project planning, data acquisition and analysis, information dissemination, storage, and archival of project materials. The success of the Klamath Network Data Management Program is dependent on the following six goals.

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- Data collected and managed by the Network is of high quality. To ensure park staff is able to utilize the data managed by the Network, the data must be accurate and complete. Appropriate quality assurance and quality control processes will be implemented throughout all phases of the data lifecycle.
- Data managed by the Network is readily available. Information products will be distributed to park employees on a regular basis to keep them informed of Klamath Network activities. In addition, the Klamath Network will maintain both an internet and intranet website that will give the parks' staff and the public access to various reports and documents. Finally, the Klamath Network will utilize Service-wide data management products to distribute spatial data and metadata.
- Data managed by the Network will be easily interpreted. Coded datasets are confusing and can be easily misinterpreted. Without documentation discussing the intended use of the data, collection methods, date collected, accuracy, and location, a user can easily become perplexed and quite possible misled about the usefulness of the data. Therefore, datasets managed by the Klamath Network will contain all documentation prior to dissemination.
- Data stored and disseminated by the Network is secure. Data managed by the Network will be screened for sensitive information prior to release. In addition, standard procedures for data storage, archiving, and versioning will be developed to maintain long-term data needs.
- Educate staff working for or with the Klamath Network about data management principles and practices. An import element of a data management system is the education of its different users. Therefore, the Network will work to ensure current and future staff members are aware of and follow documented data management procedures. The Network will also work with park staff, contractors, and seasonal employees to make sure they are familiar with current data management processes.
- Work with park staff to ensure data managed by the Network is accurate and up-to-date. The Network will need to be in constant communication with the parks that makeup the Network. Each group needs to be continually made aware of the data and products available to them. The Board of Directors, Technical Advisory Committee, and Subject Expert Workgroups are predominantly composed of NPS staff from parks within the Network.

The main body of this document will provide general information and directions for data management activities required by the Network. Many of the data management methods will be dependent on the individual projects. Standard operating procedures, protocols, and guideline documents will be developed as the Klamath Network begins the monitoring aspect of the program. These documents will provide the details on how to manage data for each monitoring or inventory project. As these documents are completed, they will be added to the appendix of this plan and posted on the Klamath Network internet website. When possible, the Klamath Network will try to utilize as many of the same standard operating procedures and protocols for each project as possible in an attempt to keep methodologies consistent. It is the intention of this data management plan to be easily adapted to all Klamath Network natural resource projects.

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1.4 Types of Data Covered by this Plan

In general, when conducting a natural resource project, field crews collect a set of quantitative and qualitative variables typically known as “raw data.” These data are then processed, analyzed, and generalized to become “information” used to write reports, run analysis, create maps, and develop brochures. For the purpose of this document, we are describing “data” in its broadest sense. It can mean anything ranging from raw data collected in the field to processed data used to create charts and statistical analyses. Data can also refer to the documentation that was developed based on the raw data and may include metadata, reports, presentations, and the administrative record (Table 3).

Table 3. Data categories with examples of potential deliverables.

Data Category	Examples
Raw Data	Field forms and notebooks, photographs, digital data (sound/video recordings, GPS data, probe data, data loggers, telemetry data)
Derived Data	Relational databases, GIS layers, maps, analyses
Documents	Protocols, data dictionaries, FGDC / NBII metadata, photograph log
Reports	Progress reports, scientific publications, annual reports
Administrative Records	Contracts, agreements, study plans, permits and applications

1.5 Sources of Data

The majority of the data managed by the Klamath Network will come from inventory and monitoring projects conducted or funded by the Network. The Klamath Network will also employ data miners to search for regional NPS legacy data to help support the inventory and monitoring objectives of the Network. Additionally, the Network will compile data from a variety of regional and national level NPS sources, other government agencies, universities, and non-government organizations to provide information that will support the I&M Program and park management needs. Data can be obtained from a variety of sources, including:

- Inventories
- Monitoring studies
- Protocol development pilot studies
- Focus studies by internal staff, park staff, contractors, and cooperators
- Research projects
- Resource impact evaluations
- Restoration projects
- Published scientific literature

Since the prospects for obtaining high quality data are best when good data management practices occur in all phases of a project, the Klamath Network will place an emphasis on providing data management support for projects that are in the beginning stages. As time,

necessity, and funding permit, the Klamath Network will attempt to incorporate our data management methodologies into the conversion of legacy data from completed projects.

1.6 Audience

The specific intended audiences of this Data Management Plan are:

- Klamath Network staff
- Individuals, agencies, and cooperators that participate in Klamath Network programs

While this plan is directed towards the immediate needs of the Klamath Network, the principles and guidelines provided can be applied to almost any data gathered by an agency, contractor, or additional sources. We intend for this plan to be informative, useful, accessible, and continue to improve through time. While the Klamath Network Data Manager is the primary author and editor of this document, the involvement of end users in refining and improving these ideas is essential.

1.7 Plan Revisions

As a dynamic document, the Data Management Plan will change as sampling methodologies improve, technology advances, and more up-to-date information becomes available. The main document will undergo a full review three years after implementation. Following the three year review, the Network will conduct a complete review every five years, with minor updates being completed as needed. Appendices will be updated on a more regular basis because they will incorporate the specific procedures and instructions for proper data management.

The version number for the data management plan will be printed on the front cover. Each minor revision will be represented by an incremental increase by hundredths (e.g. 1.01 vs. 1.02). Each major revision will include an update of the whole number (e.g. 1.01 vs. 2.00).

A revision log will be maintained and updated with the main body of this document. The log will record a short description of the revision, what sections were revised, and what date the revisions were made.

The most current version of the data management plan will be posted on the Klamath Network website at:

http://www.nature.nps.gov/im/units/klmn/index.htm

Prior to the final document, a draft version of the data management plan will be made available on the NPS Klamath Network intranet at:

http://www1.nature.nps.gov/im/units/klmn/index.htm

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2. Roles and Responsibilities

Understanding how and why the NPS manages its data are central duties each person working for the Network must comprehend in order to help the organization deliver high quality products and services. The NPS recognizes the importance of collecting data in a scientifically credible manner so that it can be used to address current and future management issues. The Klamath Network is expected to invest a minimum of 30% of our overall time into data management, analysis, and reporting.

It is important to recognize that every person working for Klamath Network will have some data management responsibilities. Each individual participating in data management needs to understand the flow of data thru all phases of an inventory or monitoring project (Table 4). As the demand for high quality, detailed data about natural resources and their role in the environment continues to increase, well managed data becomes imperative. It is crucial to an effective data management program that all employees are aware of the roles they play and their responsibilities as data stewards in those roles (Table 5).

A ***role*** is a position
(e.g., project leader)

A ***responsibility*** is a duty
(e.g., training, data validation)

In addition, because of the small size of the Klamath Network program, it will be necessary to have individuals participate in more than one role within the Network. As such, understanding the responsibilities associated with the various roles in the Network will be imperative. For example, the Data Manager might take on some of the Coordinator's duties, some crew members may help with certain Geographic Information Systems (GIS) tasks, the GIS Specialist may play a role in database development, and the Coordinator may participate in the data analysis. The Klamath Network will also entertain the idea of having individuals take on all duties associated with multiple roles at the Network if the workload is insufficient to justify the commitment of two full-time employees. In addition, the Klamath Network will make every attempt to examine the skill sets of each employee and utilize his or her skills to help the Network reach our goals while at the same time providing the employee with valuable development opportunities.

2.1 Personnel Responsibilities

Appendix P. Klamath Network Data Management Plan, Draft(continued).

Long-term monitoring data can become very complex and thus it must be managed in a manner that coincides with constantly changing technology and increased scientific knowledge. Furthermore, long-term monitoring projects can outlive the staff that is currently dedicated to those projects. These factors make data management a difficult task that goes far beyond any one individual. While everyone who plays a role in the Network has some data management responsibilities (Table 4), the primary data management tasks revolve around a core team composed of the Data Manager, a GIS Specialist, and the Project Manager. It is the core data management team's responsibility to work in conjunction with each other to provide the most accurate and useable information available.

Table 4. General data management activities and the roles of the individuals who are responsible for those activities.

Data Management Activity	Tasks	Principal Responsibility
Planning	• Project Development • Goals and Objectives • Protocol, SOP, Attribute Selection • Spatial Data Selection • Folder and Project Record Development	Network Coordinator Data Manager Project Manager GIS Specialist Program Administrative Assistant
Data Design	• Database Design • Datasheet Design • Database Documentation • Data Dictionary and Metadata Development	Data Manager Project Manager GIS Specialist Project Crew Leader Program Administrative Assistant
Training (database, collection methods, documentation)	• Database Training • Data Collection Methodologies • Data Dictionary and Metadata Development • Equipment Use	Data Manager Project Manager GIS Specialist Crew Leader / Crew
Data Acquisition and Quality Control	• Data Collection • Data Entry • Data Verification / Validation • Consistency Testing of Field Data	Data Manager Project Manager GIS Specialist Crew Leader / Field Crew
Quality Assurances, Analysis, Data Summaries	• Data Validation • Automated Data Summaries • Data Analysis • Data Quality Documentation	Data Manager Project Manager GIS Specialist
Documentation	• FGDC/NBII compliant metadata • Reports, Publications, Summaries	Data Manager Project Manager GIS Specialist
Access & Archiving	• Complete Metadata • Archive Data • Catalog Data / Reports	Data Manager GIS Specialist Program Administrative Assistant

• Distribute Information • Provide Access to Data / Reports	Project Manager

2.1.1 Network Coordinator

The Network Coordinator oversees all aspects of a project, including data management. It is the responsibility of the Coordinator to supervise the Klamath Network staff, as well as all individuals associated with a project funded by the Klamath Network. The Data Manager and Network Coordinator should work closely together to make certain data managed by the Network is accurate, complete, and accessible.

2.1.2 Data Manager

The Data Manager directs a complex program of data management activities within the Network. The person in this role has the overall responsibility for all data managed by the Network. It is the duty of the Data Manager to provide guidance and standards to everyone involved in data management. Primary responsibilities include:

The ***Data Manager*** has the overall responsibility for all data managed by the Network

- Creates data management related policies, guidelines, standards and procedures.
- Designs, implements, supports, and manages database systems for long-term monitoring projects, inventory projects, and various other I&M activities.
- Provides coordination, training, technical assistance, and professional advice to meet the data management needs of the staff.
- Works with the GIS Specialist to integrate tabular and spatial data to meet objectives.
- Works with the park staff to document legacy data and to ensure that relevant and useful data are acquired and integrated into the Klamath Network program's databases.
- Provides access and security to data and information managed by the Network.
- Makes available appropriate documentation of data.

2.1.3 GIS Specialist

The GIS Specialist is responsible for the development, coordination, and implementation of the spatial systems and products for the Network. Specific responsibilities include:

- Determines the GIS data and analysis needs for individual projects.
- Develops procedures for field collection of spatial and Global Positioning System (GPS) data and techniques.
- Conducts spatial analysis of project-related data.
- Documents data in compliance with NPS, Federal Geographic Data Committee (FGDC), and National Biological Information Infrastructure (NBII) metadata standards.

- Negotiates cooperative and interagency agreements to effectively carry out the GIS program to meet data management goals.
- Creates products and presentations that can be used for outreach and interpretive programs to help educate staff, government employees, scientific community, and the general public about the Network and our goals, objectives and accomplishments.
- Establishes and implements procedures to protect and disseminate sensitive spatial data according to project needs.

2.1.4 Project Manager

The Project Manager is responsible for all phases of an inventory and monitoring project. The person in this role works closely with the Data Manager, GIS Specialist, and field crew members to ensure data management protocols, standard operating procedures, and guidelines are being followed. It is one of the Project Manager's core responsibilities to make sure information collected in the field is accurate, complete, and correctly documented. Overall data management duties of the Project Manager are:

- Selects and develops, in close collaboration with the Network Coordinator and Data Manager, the protocols, standard operating procedures, and sampling methodologies that will be implemented for each project.
- Supervises and certifies all field operations including training, equipment handling, data collection and entry, quality control (QC) / quality assurance (QA) measures, verification, and validation.
- Transfers data to the Data Manager on a schedule determined during the planning phase of a project.
- Documents all field activities that relate to data management.
- Works with the Data Manager and Network Coordinator to determine workload priorities, timelines, summaries and final reports, and deadlines.
- Serves as the point of contact for all data collection issues on the projects he or she manages.

2.1.5 Collaborative Duties

Throughout the development and implementation of Klamath Network-funded projects, there are several duties that members of the core data management team (including the Data Manager, Project Manager, and GIS Specialist) will need to work closely together to perform (Figure 3). These additional responsibilities include:

- Develops quality control and quality assurance measures and methodologies for individual projects.
- Documents all data collected for a project including reports, metadata and data dictionaries.
- Determines methodologies for data collection, entry, quality control, transfer, storage, and dissemination for each project.

- Identifies sensitive project information and develops levels of access to and timelines for dissemination of that information.
- Coordinates changes to any aspects of a project including collection methodologies, data forms, data entry, storage procedures, and databases
- Develops user-friendly interfaces for data entry that incorporate quality control measures.
- Determines information needs that will be required by the end-user.

2.1.6 Program Support Assistant

The Program Support Assistant will work closely with all personnel involved in a project to provide support in a variety of administrative and data management duties. Responsibilities include:

- Assists the Data Manager with the maintenance of the Klamath Network intranet and internet websites.
- Works with Project Managers to provide administrative support for all aspects of a project, including but not limited to payroll, logistics, purchasing, travel, etc.
- Understands and follows the Data Management Plan and standard operating procedures, specifically in regards to disseminating documents or databases, naming and storing administrative records, and QA/QC processes.
- Works with the Data Manager to help in database development, storage, and archiving.
- Coordinates with the Network Coordinator to provide administrative support for all aspects of the Network, including but not limited to payroll, logistics, purchasing, travel, etc.
- Manages the project database by coordinating with the Project Managers, Network Coordinator, and Data Manager to ensure everyone is aware of upcoming deadlines, the availability of project deliverables, and the overall status of a project.

Appendix P. Klamath Network Data Management Plan, Draft(continued).

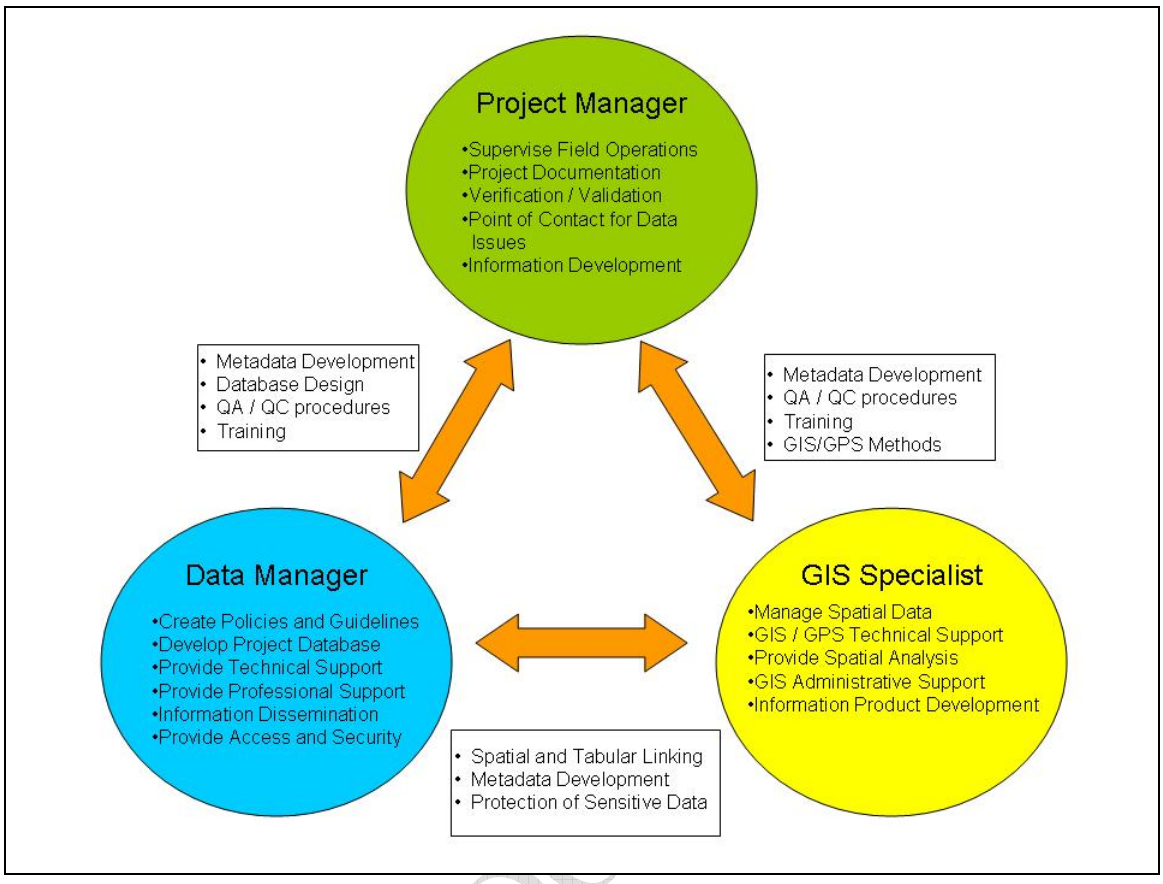

Figure 3. Breakdown of the roles, duties, and combined responsibilities of the core data management team members.

2.1.7 Crew Leader

The Crew Leader is a key position in any project. The person in this role will be the most knowledgeable about how a project is being implemented in the field. The Crew Leader must work closely with the Project Manager in many of the data management activities to ensure their implementation and refinement, as necessary. The general responsibilities of the Crew Leader are:

- Works with the Project Manager to ensure field crews are properly trained on data management methods, equipment use, and sampling methodologies.
- Supervises field crew members to ensure that they consistently and accurately record data according to specified methods.
- Validates all data entered by field crews prior to transferring the information to the Project Manager.
- Reports data management issues (e.g., collection or entry methods, errors, GPS/GIS technology, etc.) to the Project Manager.

- Ensures metadata are made available for all data including photograph logs, training logs, datasheet logs, etc.
- Transfers all data materials to the Project Manager on a predetermined schedule.

2.2 Data Management Coordination

Chapter 4 of the 2006 NPS Management policies states "The service will pursue opportunities to improve natural resource management with parks and across administrative boundaries by cooperating with public agencies, appropriate representatives of American Indian tribes and other traditionally associated peoples, and private landowners…the service will develop agreements with federal, tribal, state, and local governments and organizations; foreign governments and organizations; and private landowners, when appropriate, to coordinate plant, animal, water, and other natural resource management activities in ways that maintain and protect park resources and values."

In order to achieve the goals of the Klamath I&M Network, cooperation and coordination with National I&M personnel, the other 31 "vital signs" networks, park staff, government agencies, universities, research organizations and other non-government agencies will be essential in the development of the Klamath Network Data Management Program.

Because natural resources in the parks, and threats to them, do not adhere to political boundaries, development of a well-organized Data Management Program must facilitate science and foster partnerships among Data Managers, Coordinators, scientists, and other natural resource professionals throughout the NPS, scientific community, and other regional organizations.

Table 5. General summary of Klamath Network roles and the data management responsibilities.

Role	Data Responsibilities
Project Crew Member	• Collect, enter and verify data • Document and report issues with data collection, data entry, and QA/QC process to the Crew Leader
Project Crew Leader	• Train and supervise field crews • Organize and verify data • Report issues with data collection or documentation to the Project Manager.
Project Manager	• Supervise Project Crews • Train Project Crew Leader on proper data management • Validate data • Provide data documentation • Convert data into information • Select protocols and standard operating procedures
Network GIS Specialist	• Process, manage, and validate spatial data • Make spatial data accessible and useable • Conduct spatial analysis

Network Data Manager	• Work with Data Manager to integrate spatial and tabular data • Manage GPS data • Train Project Manager on proper data management • Develop and support a network data management system • Ensure Klamath Network managed data are organized, documented, accessible and safe • Train staff in proper data management methodology
Network Coordinator	• Coordinate and oversee all network activities
Information Technology Specialist	• Provide support for all hardware, software, and networking
Park Curator	• Oversee all aspects of specimen acquisition, preservation, and documentation • Manage the collections for parks in Klamath Network jurisdiction.
Park Resource Managers	• Inform scope and direction of Klamath Network needs • Integrate information provided by Klamath Network into park planning and management decisions
Superintendents	• Inform scope and direction of Klamath Network needs • Integrate information provided by Klamath Network into park planning and management decisions
I&M Data Manager (National Level)	• Provide service-wide support

2.2.1 Southern Oregon University

The NPS and SOU are both participants in the Pacific Northwest Cooperative Ecosystem Studies Unit, part of a nationwide network of similar units organized around bio-geographical regions for the purpose of providing high-quality scientific research, technical assistance, and education through the linking of participating agencies and university partnership. In 2004, the Klamath Network entered into a task agreement with SOU to establish an administrative office on the main campus, providing the program with access to the information technology, communication, and research capabilities of SOU. Within this agreement, SOU provides:

- A Principal Investigator to oversee all collaborative activities and to ensure that Klamath Network and SOU requirements are met.
- Facilities and infrastructure support including offices, laboratories, libraries, computer-related services, equipment, supplies, telephone services, and meeting rooms.

In return for SOU's services, the Klamath Network provides:

- Financial assistance on a yearly basis for the amount approved in the Klamath Network Annual Administrative Report and Work Plan.
- An Agreement Technical Representative (ATR) to collaborate with the University Principal Investigator.
- Involvement for faculty and students in research, internships, employment, and educational opportunities where appropriate and mutually beneficial.
- Staff to provide guidance and consultation with students and faculty as needed and appropriate with ongoing activities.

Appendix P. Klamath Network Data Management Plan, Draft(continued).

2.2.2 National Park Service

National to Network: The National I&M Program have worked closely with the 32 regional networks to design and develop data management methodologies and tools. Such tools as NPSpecies, NatureBib, Natural Resource Database Template (NRDT), GIS Theme Manager, and Dataset Catalog are a few. In addition, the Klamath Network has taken advantage of tools created by other divisions with the NPS including NPSTORET, NPS Metadata tools, NPS Data Store, and the Research Permit and Reporting System (RPRS). In addition, the National I&M Data Manager works to keep abreast of developing trends, innovations, guidelines, and educational opportunities in data management and communicates with Network Data Managers by various media.

Network to Network: Each of the 32 Networks within the NPS Inventory & Monitoring Program is required to have at least one Data Manager. These Data Managers form a distributed community of working technical professionals that coordinate regularly through conference calls, regional and annual meetings, workgroups, list serves, websites, and one-on-one conversations. This communication is essential to provide the NPS with data that can be integrated and analyzed across multiple parks and networks. Frequent communication allows for the improvement in quality and efficiency in the development of data management methodologies, protocols, standard operating procedures, and guideline documents. In addition, communication among networks provides opportunities in technology sharing, idea development, cost efficiencies, and partnerships.

The Klamath Network will maintain an active role in promoting communication among networks. We are currently utilizing products, templates, and reports developed by other networks and will continue to share products, reports, and ideas developed at the Klamath Network.

Network to Park: In developing a Data Management Program, it is important to keep the end users in mind at all stages. Ultimately, the Klamath Network program is designed to serve park managers and the public, with periodic contributions to the broader scientific community. Collaboration between the Network and the six parks within the Klamath Network, therefore, will be essential if the program is to succeed. The Board of Directors, Technical Advisory Committee, and Network Workgroups include primarily park-based staff, providing frequent forums to inform the parks about key findings and to engage them in planning and analysis activities. Although I&M staff bear the responsibility for implementing the program day-to-day, we will collaborate closely with these working groups to make sure the needs of the parks are being met.

3. Infrastructure and Systems Architecture

Infrastructure refers to the basic structure or features needed to perform one's task and includes the computers and servers that Klamath Network relies on to store, maintain, and disseminate data. System architecture refers to the applications, repositories, and tools supported by the infrastructure that Klamath Network utilizes to manage data. In order to meet the overall goals of the I&M program, it is important to understand how the data managed by the Network will be stored, maintained, and distributed over the life of each project and for future users of the data. This chapter discusses the components of the Klamath Network system architecture and infrastructure needed to provided a lasting product that is distributed to a diverse group of users.

3.1 Infrastructure

Our Network relies heavily on park, regional, national and university information technology personnel and resources to maintain the overall infrastructure of the Network. Southern Oregon University IT staff is responsible for server maintenance, security, software updates, telecommunication networks, archiving, and routine backup for the Klamath Network administrative office. NPS information technology staff is responsible for maintaining computer hardware, software programs and updates, administrative functions, and security.

The Klamath Network Data Management Program infrastructure must include the following elements and functions:

- A repository for active datasets, backups and archived data.
- Support for desktop, email, and internet applications.
- System and data stability and security.
- Functional telecommunication hardware and software.
- Relevant computer hardware and software.
- A means to upload and download data by the Network, parks, and public.

The file server infrastructure used by the Klamath Network includes remote servers maintained at the national NPS office and Southern Oregon University campus (Figure 4). These servers can be divided into five categories:

- Work File Server – A server available with read/write access to all Klamath Network staff where shared files are stored

- Data File Server – A read-only repository of data files. Write access to these files is under strict control by the Data Manager and GIS Specialist. This server generally houses data that is stagnant, such as data from completed projects, GIS data, and imagery.
- Database Servers – An enterprise level server that runs on a relational database management system (RDBMS) such as Structured Query Language (SQL) server, Oracle, or Arc Spatial Database Engine (ArcSDE).
- Application Server – Provides users access to applications that can be utilized to access data in the database or internet servers.
- Internet Server – This server provides various features associated with the internet including web page and database applications, data and information products, and photographs and imagery.

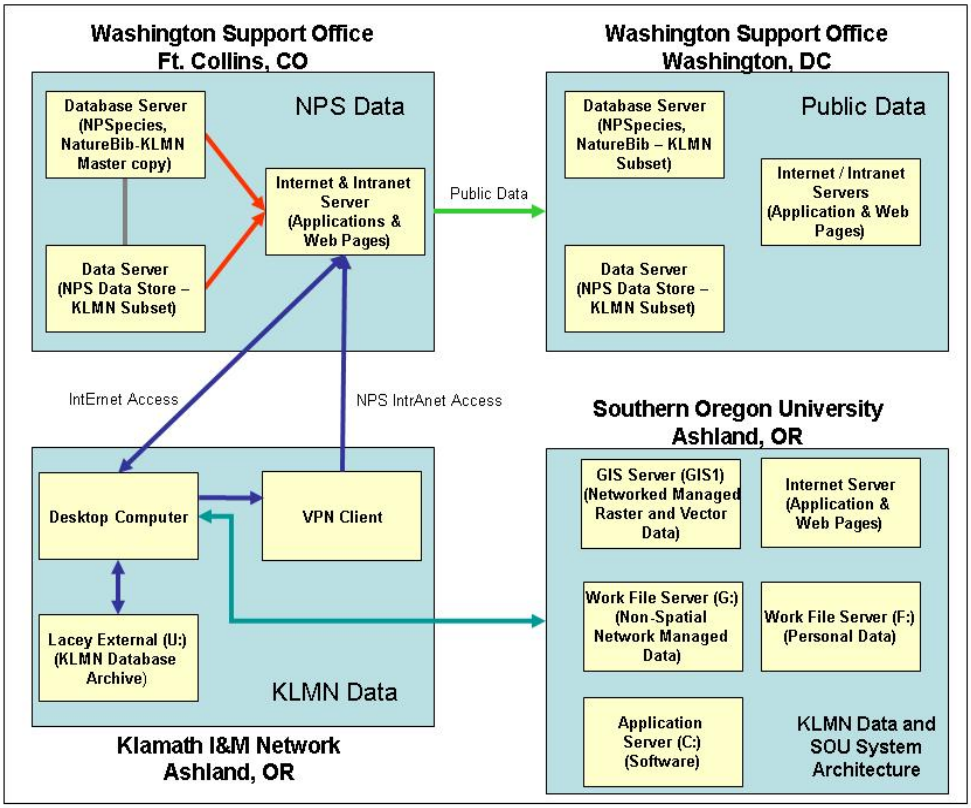

Figure 4. Diagrammatic of the infrastructure that the Klamath Network relies on for data management processes.

3.2 System Architecture

The systems architecture the Klamath Network will rely on comes from a variety of sources including the regional and national NPS offices and Southern Oregon University. The following sections discuss various components of the system architecture the Klamath Network will utilize for all our data management needs.

3.2.1 Data Management Software

The software used by the Klamath Network will abide by NPS standards and policies. Any software used to create information or manage data must be approved by the Data Manager prior to creation. As new products become available, the Klamath Network staff will determine each product's usefulness, and when desired, incorporate those products into the Network system architecture. Current standard practices for the use of various programs for data management are listed below.

Word Processing

Textual documents created for the purpose of reporting data or information about a Klamath Network project will be finalized in Microsoft Word. Documents being distributed will be converted to a PDF format using the latest version of Adobe Acrobat. A copy of the report in Word and in PDF format should be saved in the project folder.

Databases

Databases utilized to enter, store, or maintain data will be created in the latest version of Microsoft Access. If a database other then Microsoft Access is to be used, prior approval by the Data Manager is required.

GIS products

GIS products must be compatible with ESRI ArcGIS software. GIS products will need to meet NPS and FGDC standards and be completely documented prior to dissemination or use in analysis.

The Klamath Network is currently in the process of working with SOU to develop an Oracle server based system as a repository for GIS I&M data. It is the Network Data Manager's responsibility to work with the GIS Specialist and SOU IT personnel in managing this server. No GIS data will be incorporated into the server unless the data are accompanied with complete metadata.

3.2.2 Working Project Files

Currently, data managed by the Klamath Network is stored on one Network drive (G:) that can be accessed by all Network employees who have an SOU login account. The Network makes every attempt to name folders on the drive in a concise yet descriptive manner so users unfamiliar with the structure may easily adapt to the system. All folder names must follow the Klamath Network Naming Convention standard operating procedure available on the Klamath Network intranet website. Prior to adding a new folder to the Network's "G" drive, one should consult the Data Manager to determine the best location for the folder. The Klamath Network manages a variety of level one (Figure 5) files and the structure of each folder varies depending on its content. However, for the inventory, monitoring, and project folders, we will use a broad to fine scale structural approach that involves four levels (Figure 6).

Level One

The first level contains ten folders of the broadest category listed in Section 4.2 of the Klamath Network Naming Convention standard operating procedure. For project data, folders at this level are entitled Inventories, Monitoring, and Projects. The “Inventories” folder contains any inventories the Klamath Network funded or conducted. Similar to the “Inventories” folder, the “Monitoring” folder contains monitoring projects the Klamath Network has funded or conducted. The “Projects” folder will contain projects that do not “fit” into the inventory or monitoring category.

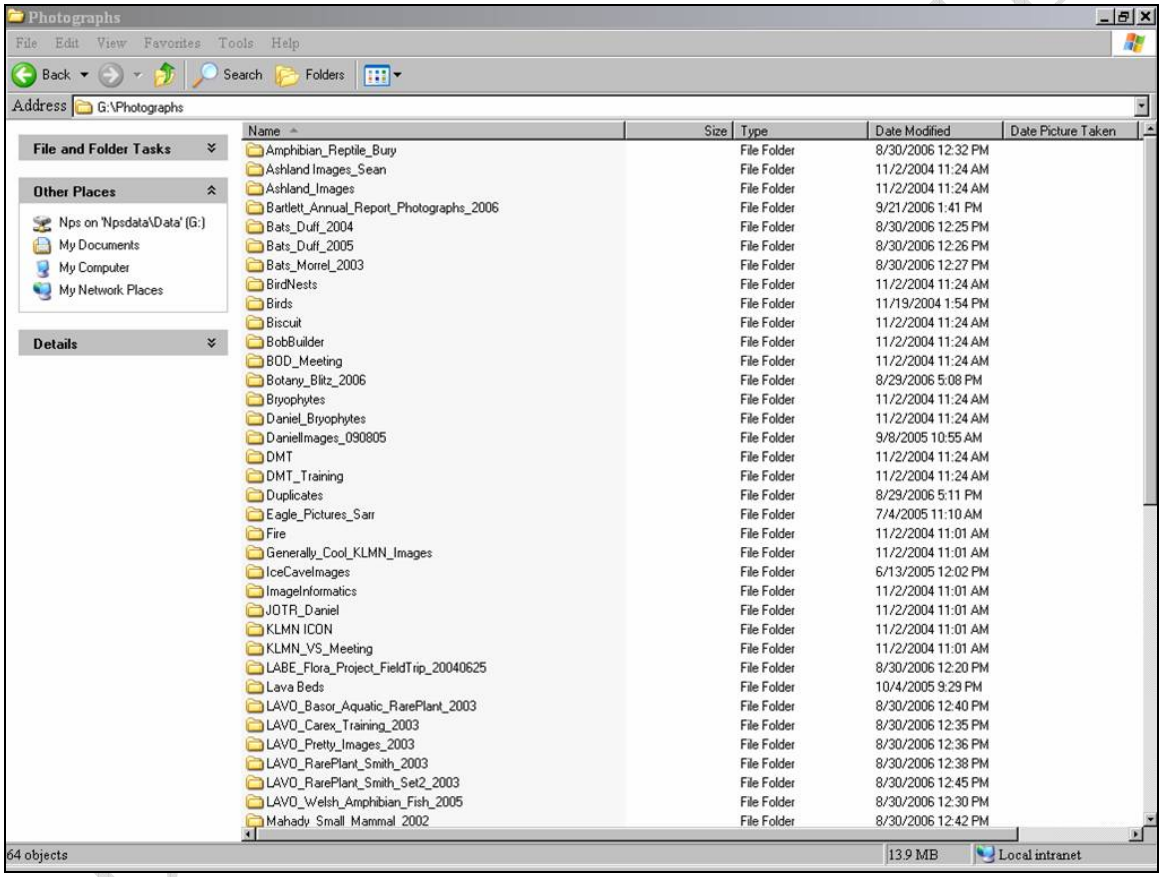

Figure 5. Level 1 file folders structure on the Klamath Network drive (G:).

Level Two

The second level of folders is for individual projects. Each project folder has and will continue to have a naming convention that includes a title and a year. The title should include the project topic, principle investigator’s last name, and the starting year of the project. Some examples of folders at this level are Vegetation_Odion_2006, Bats_Duff_2005, and Intertidal_Anderson_2004. On the rare occasion that multiple

projects by the same principal investigator on similar topics occur, the Data Manager and Project Manager will develop unique names for each project folder.

Level Three

The third level in the filing hierarchy is structured the same for all projects. It contains five folders that each includes the project title and one of the following: Documents, GIS, Data, Images, or Analysis. These five folders will contain the data and information for each project. Subfolders may be used to help organize the data; however this will be dependent on the project and will be defined as necessary.

- Documents. This folder will contain the reports, budgets, work plans, emails, protocols, contracts, and agreements associated with a specific project.
- GIS. This folder will contain any shapefiles, coverages, layer files, geodatabases, GPS files, GIS/GPS associated metadata, and spatial imagery associated with a project.
- Data. This folder will contain non-spatial data collected in the field and its associated metadata.
- Images. This folder will contain any photographs related to the project and an associated image log.
- Analysis. This folder will contain derived data and associated metadata created during analysis.

Level Four

Level four contains the databases, spreadsheets, spatial data, photographs and supporting documents for each project. Additional folders may be added to organize the materials that are stored in level four. For example, a folder could be created within the level three "Documents" folder called "Reports" that will contain all the annual reports and final reports for a specific project.

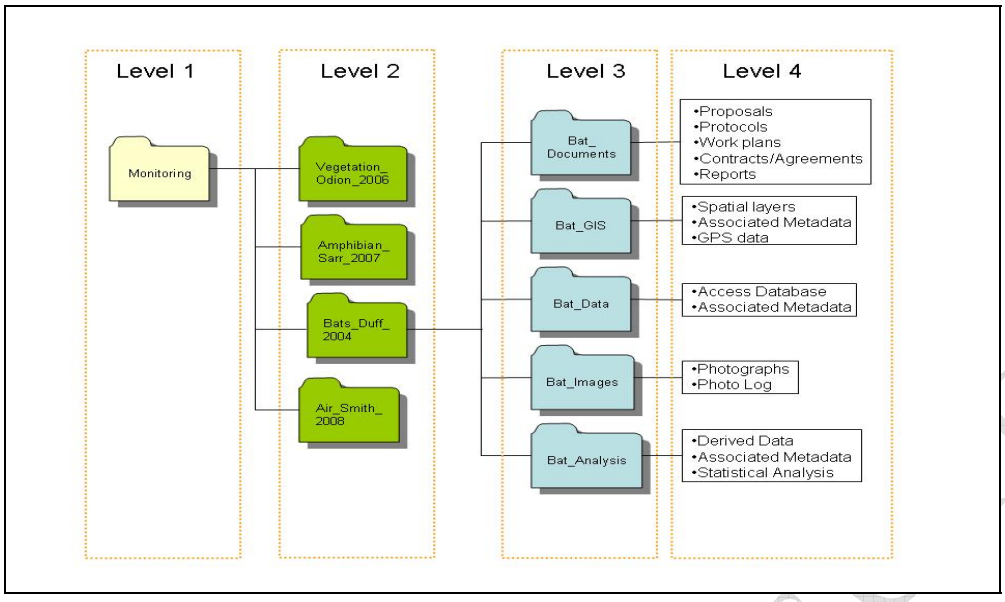

Figure 6. An example of the general file structure the Klamath Network will use to store and maintain project data.

3.2.3 Relational Database Structure

A relational database designed for scientific applications faces unique challenges not seen in traditional business-oriented database systems. Scientific databases must contend with the enormous variability in data sampling methodologies and measurement precision in specific projects. It is not uncommon to have project goals and objectives change over time so a database must be designed in a manner that makes it adaptable to change over the life of the project. Additionally, the 32 Networks in the I&M Program adapt and utilize databases built by each other to reduce the amount of time, effort, and funding needed to develop multiple databases by a single Network. Because we need to take into account Networks that may utilize and adapt a database we design, the Klamath Network will work to keep design methodologies as simple as possible making them available to an audience that has a variable skill level in database design.

When developing a database it is important to answer four main questions:

- Why do you need the database? It is important to address the overriding need for a database. The project group must determine if the data are important enough to warrant a database. One must consider the funding that will be needed not only to develop the database, but also to maintain it for the life of the data.
- Who is going to be the audience of the database? If someone can not define specific groups that will utilize the database, then that person may want to reconsider developing one.
- What questions will the user expect to answer? This is the most important question when developing a database. Understanding how users will want to summarize the data stored in the database is essential and should be addressed prior to development. A good rule of thumb: the designer should have a fairly

clear concept of what the standardized reports will look like prior to developing the database.

- How will you encourage the user to utilize the database? Long-term databases can outlive the original designer and manager. It is import to define who will use the database and more importantly, why they will use it. Determining the benefits a user will gain by utilizing a database will be essential to the present and future effectiveness of the database.

The Klamath Network will make every attempt to utilize databases that have already been developed for a monitoring project. If a database is not available, we will adapt the Klamath Network Natural Resource Database to meet the needs of the project. The Klamath Network Natural Resource Database is a Microsoft Access database that uses variables specific to this Network and is modeled after the Version 3 Natural Resource Database Template developed by the National I&M office.

Natural Resource Database Template

The NPS Inventory and Monitoring (I&M) Program's Natural Resource Database Template (NRDT) is a core relational database structure that can be modified and built upon by different parks and networks, depending on the components of their inventory and monitoring programs and the specific sampling protocols they use. Monitoring protocols that include a NRDT-based application will be made available through the national web-based monitoring protocol clearinghouse. Users may download a written protocol for some monitoring component (e.g. weather or bird counts) along with database. The Natural Resource Database Template:

- Provides both a data interchange standard and a standard Microsoft (MS) Access database core that allow flexibility in application design.
- Serves as a starting point for application development that can be extended as necessary to accommodate any inventory or monitoring field sampling protocol.
- Standardizes location and observation data to facilitate the integration of datasets.
- Acts as a design platform for developing database applications in MS Access, allowing users to enter, edit, display, summarize, and generate reports for inventory and/or monitoring datasets.
- Integrates with other I&M data management systems and data standards including the NPS Data Store, GIS tools and data, the NPS GIS Committee Data Layers Standard, and the NPS Metadata Profile.

Utilizing the NRDT template and working with staff from Crater Lake National Park, the Klamath Network developed the Klamath Network Natural Resources Database. The Klamath Network Natural Resources Database represents a standardized set of database tables, structures, and field definitions, along with an associated user interface consisting of user displays, forms, reports and queries, which may be used with a wide range of natural resource field data.

Klamath Network Natural Resources Database

The software and data structures comprising this database are contained within two separate but tightly coupled MS Access database files utilizing the Joint Engine Technology (JET) database manager. This design is a modification of the classic two tier design and is commonly referred to as a "back-end" and "front-end." The classic two-tier design identifies separate database and user interface layers, whereas this design consists of a separate database layer and a mixed database/user interface layer through the use of linked database tables within the user interface layer. Figure seven illustrates three connected back-end databases; however, the front-end can accommodate hundreds of compatible "back-end" databases.

The user interface encapsulates the Inventory and Monitoring recommended design, *The Natural Resource Database Template Version 3* and the *Klamath Network's Site Information Form*. The user is presented with a number of interface displays to enter data, retrieve data, and perform some maintenance activities.

The Klamath Network will utilize the Klamath Network Natural Resources Database whenever possible for all inventory, research, and monitoring projects funded by the Network. It is the Data Manager's responsibility to adjust and develop the current database structure so that it meets all project objectives. When feasible, we will convert non-NRDT compliant databases used in several Klamath Network vital sign monitoring projects into the Network template at the end of each inventory project or monitoring field season. For more details on the NRD database refer to Klapatch 2005 and Klapatch and Truitt 2005.

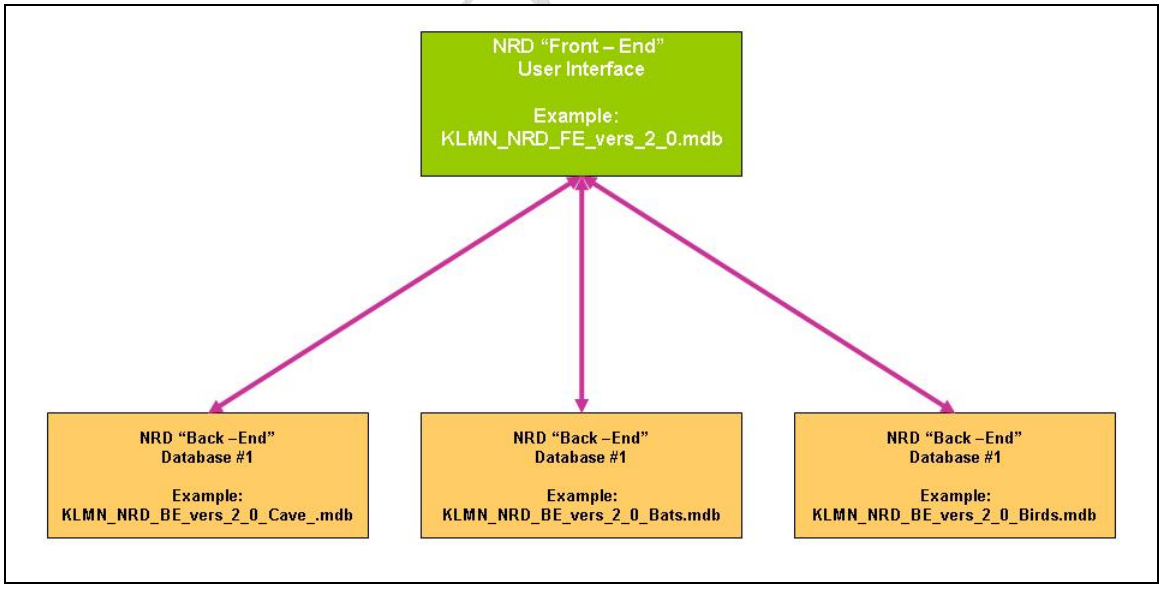

Figure 7. System overview of the Klamath Network natural resource database.

3.2.4 Master Data Library

The Data Manager is responsible for a master data library that stores project deliverables. Prior to incorporating data into the master library, all data must be properly documented and have passed QA/QC procedures outlined in the planning phase of each project. Klamath Network employees will have read-only access to the library; but only the Data Manager will have write access.

The master data library will be backed up on a weekly and quarterly basis by Southern Oregon University. In addition, the Data Manager will backup the library as new products are added. The backup completed by the Data Manager will be stored in an external Lacie drive. The master data library will maintain a similar structure to the working project folder described above.

3.2.5 Internet Servers

The Klamath Network Data Manager will work with the Program Assistant to provided information via the internet and intranet in a complete and timely manner. It will be the responsibility of the national NPS office and Southern Oregon University to maintain the internet servers.

3.2.6 IT Network Security

The Klamath Network will rely on the national and regional NPS offices and Southern Oregon University to provide adequate security. Klamath Network staff will comply with all security procedures outlined by these agencies, including training as required.

4. Data Management Process and Workflow

This section will detail the data management methodologies the Klamath Network will follow during the six phases of the data lifecycle (Figure 8). Understanding how data are developed allows us to easily communicate the overall objectives and importance of proper data management throughout each phase of a project. The intent of this chapter is to give a general overview of a project workflow; more detailed information may be found in other chapters and the appendices of this document.

The Klamath Network will adhere to the data management methodologies associated with the data management lifecycle (Figure 8). The data lifecycle is a simple six step process to developing and managing data throughout the lifespan of a project. It is recognized that when dealing with natural resource information, much variation can occur while following the data management workflow. Although the six step process has clear duties associated with each phase, those phase generally overlap and duties in multiple phases can be carried out concurrently. The Klamath Network will adhere to the data management methodologies associated with the data lifecycle as budget, time and project goals allow.

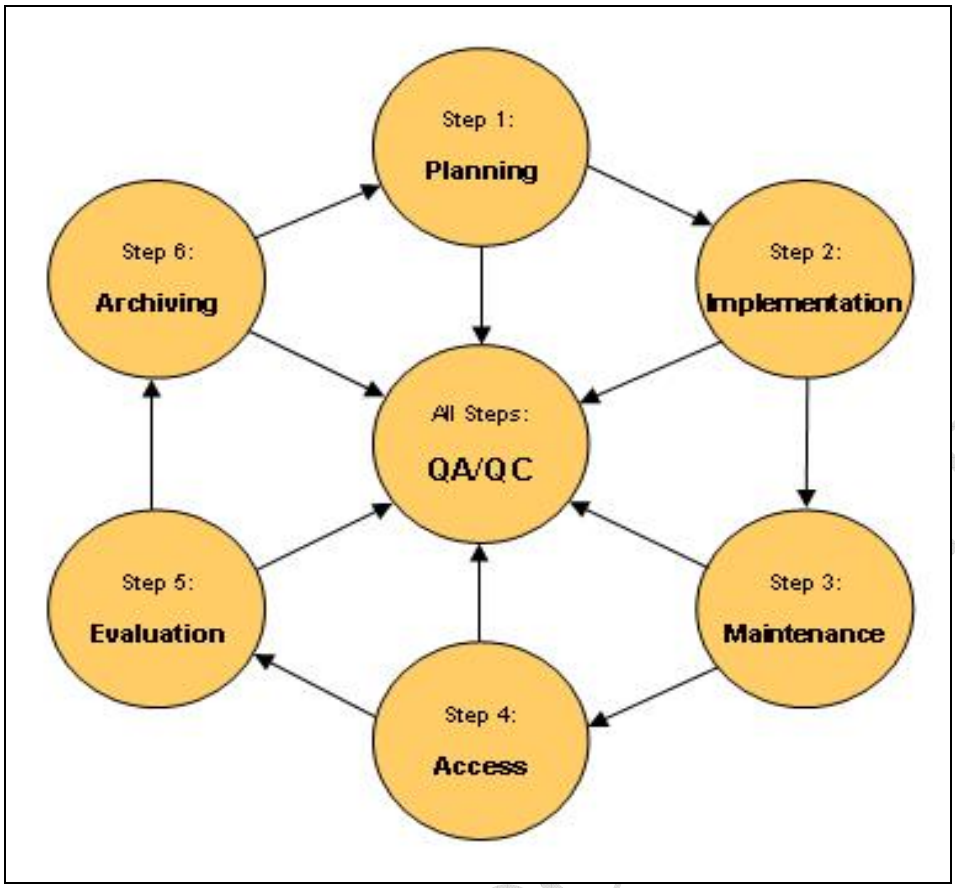

Figure 8. Conceptual Model of the 7 steps of the data life cycle.

While the Klamath Network will deal with a large variety of data, this chapter will discuss data management associated with two main types of projects:

- Short-term projects. These projects include a variety of studies that are usually completed between one and five years. Two examples are inventories and pilot projects.
- Long-term projects. These are monitoring projects that will be designed to last greater than five years. These projects tend to extend beyond current technology, personnel, and data collection methodologies. Long-term projects usually acquire more data than short-term projects and require a higher level of documentation and data management.

In planning a short or long-term project it is still necessary to follow the data lifecycle. Each project will produce similar data (Table 6) that will need to be managed and made available to a diversity of users.

Table 6. Categories of data that will be managed during an I&M project.

Data Category	Examples

Raw Data	Field forms and notebooks, photographs, digital data (sound/video recordings, GPS data, probe data, data loggers, telemetry data)
Derived Data	Relational databases, GIS layers, maps, analyses
Documents	Protocols, data dictionaries, FGDC / NBII metadata, photograph log
Reports	Progress reports, scientific publications, annual reports
Administrative Records	Contracts, agreements, study plans, permits and applications

4.1 The Data Lifecycle

From the time it is decided to collect data until the data become obsolete, those data need to be accounted for and managed. Following the data lifecycle (Figure 8) approach to data management allows personnel to understand the various stages of a project design and how data management plays a role in each stage. It is important that every individual participating in a project funded or sponsored by the Klamath Network understands the data lifecycle and realizes that the information we are collecting will go far beyond the immediate needs of the project.

The information we are collecting will go **far beyond** the immediate needs of the project

4.1.1 Planning

Planning is the first and one of the most important steps in the data lifecycle. The planning phase can be a complex and arduous process. However, spending the time to meticulously plan all aspects of the project will save a considerable amount of time, effort, and money in the other phases of the project. During the planning phase:

- Goals and objectives of the project are determined and clearly stated.
- Ownership of the data and products is determined.
- A project record is created in the Klamath Network project tracking database.
- Inventories of related information are reviewed and rated for usefulness.
- Proposals and budgets are created and funding sources are determined
- Work plans are created
- Contracts, agreements, and permits are obtained
- Protocols, standard operating procedures, and guidelines are selected or developed as needed
- Attribute entities and rule sets are defined.
- Databases, datasheets, metadata, and data dictionaries are designed
- Deliverables are identified and due dates are determined
- Storage and dissemination methods are created
- Timelines are determined

4.1.2 Implementation

The implementation phase of the project is when the on-the-ground work begins. It is during this phase that we can begin to determine what data management methods are

working, what methods need to be adjusted, and what methods need to be reassessed. During the implementation phase:

- Field crews, contractors, and additional personnel are hired and trained.
- Equipment is purchased.
- Data are collected, entered, undergo quality assessment (QA) and quality control (QC) processes, certified, stored, and secured.
- Data are converted to information through statistical analysis, GIS analysis and map development, creation of dataset catalogs and metadata, and preparation of reports.

4.1.3 Maintenance

In order to maintain the highest quality useable data, continuous maintenance, conducted on regular intervals, of the data and the products created from the data (metadata, databases, and the administrative records) needs to occur. During this phase:

- Metadata, data catalogs, and data dictionaries will be evaluated to make sure they are up-to-date and meet all previously outlined standards.
- Seasonal data will be reviewed prior to integration with the master databases to make sure they are complete and meet data quality standards.
- Records in the project database are updated.
- Data will be screened for sensitive information and protected from unauthorized use.
- Databases and datasheets are updated to meet current objectives.
- Known users of the information are informed of any revisions to the data or supporting documents.

4.1.4 Access

One of the core goals of most Klamath Network projects is to create information that can be utilized by park staff and the scientific community, providing them with up-to-date information about natural resources occurring in and around the parks. To do this job efficiently, methodology must be in place to allow users easy access to tabular and spatial data, reports, and photographs collected during the project. In this phase:

- Products and data are distributed to a diversity of users including park staff, Klamath Network employees, SOU personnel, national I&M databases, and the scientific community on a predetermined timeline.
- Data are stored in a manner that is secure but allows for timely distribution when needed.
- Information created from the project is posted to or used to update national databases including NPSpecies, NatureBib, NPS Data Store, STORET, ANSC+, and NR-GIS Clearinghouse as needed.

4.1.5 Evaluation

The technology, methodology, and perspectives used to create and implement a project are dynamic and can change on a regular basis. It is important to constantly review all the aspects of a project to determine what is working; what needs to change; what needs to be added; and most importantly, what can be done better or more efficiently. During this phase:

- Evaluation of the collection methodologies, protocols, standard operating procedures, and guidelines is conducted to determine if they are still valid.
- Periodic evaluation of the data being collected takes place to determine if they are still needed and useful.
- Overall evaluation of the project occurs to determine if the methodologies being used are in a direct relation to the goals and objectives of the project.
- Evaluation of the data management methodologies used to obtain, manage, disseminate, and archive the data transpires to make sure the methodologies are still efficient.

4.1.6 Archiving

As stated in the 2006 NPS Management Policies, "Information about natural resources that is collected and developed will be maintained for as long as it is possible to do so. All forms of information collected through inventorying, monitoring, research, assessment, traditional knowledge, and management actions will be managed to professional NPS archival and library standards." The Network will utilize the infrastructure provided by Southern Oregon University and Redwood National and State Parks (RNSP) to meet our archiving and storage needs. All Klamath Network information will be backed up on a nightly, weekly, and quarterly basis. Weekly and quarterly backups will be stored off campus and managed by Records Masters of Southern Oregon. Weekly backups will be stored for approximately two months while quarterly backups will be archived for one year. In addition, the Klamath Network will keep an archived copy of all project related data on an external hard drive that will be stored on-site. This archived copy will be updated on a weekly basis if a change has occurred to any information in the project folder. In order to preserve the data for long-term use, archived data must:

- Be secure and easily accessible to meet future requests (e.g., FOIA, parks staff, and the scientific community).
- Include all documentation needed to understand the archived datasets and GIS information. This includes administrative documents, reports, metadata, and data dictionaries.
- Be stored in its original format and in a comma-delimited, American Standard Code for Information Interchange (ASCII) text file. ASCII files will include the content of each file, relationships that may occur between tables, attribute definitions, and associated documentation.

4.1.7 Quality Assurances / Quality Control

Data collected for the purpose of detecting a change in natural resources over time must be of the highest quality with little or no bias. Applying proper QA/QC standards to the entire data lifecycle, from the planning phase through the archiving phase of the data life cycle will allow Klamath Network to provide high quality, accurate data for scientific analysis and natural resources support. In this phase:

- Metadata files created during the planning phase of the project will be updated through every stage of the project.
- Validation and verification methodologies will be used to protect information being collected, recorded, and processed.
- Completeness and accuracy of data will be determined prior to distribution or incorporation of that data into the master database.
- Domain values, pick lists, and various other quality control methods will be incorporated into the databases prior to data entry
- Monitoring projects will have consistency checks of the data conducted to make sure data collected over multiple years can be integrated.
- Data will be reviewed at multiple levels to correct errors and determine missing values.
- The Data Manager will monitor project folders to ensure all data are available and located in their proper place.

5. Data Acquisition and Processing

This chapter describes the processes and guidelines the Klamath Network will follow for acquiring or collecting datasets, entering or integrating datasets into a project database, and digitizing datasets for use with a computer. Because data are collected using varied equipment and sampling methodologies, stored in different formats and locations, and used for a variety of purposes, there is no single data collection protocol that is suitable for all projects within a park. The origin and purpose of the data will dictate the processes and procedures Klamath Network will use to acquire, verify, and utilize the information. Data managed by the Network fall into three generalized categories:

- Programmatic data – Data that was obtained from projects conducted or fully funded by the Klamath Network.

- Non-programmatic NPS data – Data that was produced by the NPS but the Klamath Network did not have any involvement or provided only minimal amount of funding.
- Non-programmatic external data – Data that was produced by a source outside the NPS.

Regardless of where the data originate, their overall quality and associated documentation are key factors in determining the importance of the data for inventorying, monitoring, and managing park resources.

5.1 Programmatic Data

Since projects that fall into this category are funded or conducted by the Klamath Network, we will have the greatest control over the protocols, standards, and methodologies used to obtain and manage their data. The data management methodologies used in a given project will depend on the needs outlined and protocols developed during the planning phase of that project. Some general data management methods the Klamath Network will follow are listed below for the various stages of the data lifecycle.

5.1.1 Data Collection

Project and Research Planning: Prior to project implementation, methodologies for data acquisition will be clearly stated. Legacy data will be examined to determine if there is any useful information available. GIS data will be checked for usefulness and obtained along with corresponding metadata. Data dictionaries describing each attribute to be collected will be developed and utilized to create databases and field forms for the project. Timelines and templates for deliverables will be developed.

Field Sampling

Once field sampling begins, it will be the Field Crew Leader and Project Manager's duty to adequately train field crews in the data collection and management methodologies outlined in the project plan. Field crews should be effectively trained in equipment use, sampling methods, database and datasheet use, data entry, transcription, backup procedures, and quality control standards. They are expected to follow the elements of the Data Management Plan germane to their project. Such elements will be determined in the planning and research phase. In addition, standard operating procedures and guideline documents (selected in the project's planning phase) will be adhered to with regular checks by the Project Manager and Data Manager to determine if correct procedures are being followed.

Automated Data Collection Devices

Whenever possible, Project Managers will be encouraged to utilize electronic equipment for data collection. This includes, but is not limited to GPS units, probes, and data loggers. Electronic systems will be backed up by the field crews in a timely manner.

Backup times will vary depending on the equipment and methods being used but will be determined prior to the start of the field season. Calibration techniques for field equipment should be documented in a log and discussed prior to utilizing the equipment

Cameras

Photographs are a valuable tool used for a multitude of objectives including outreach, specimen identification, displaying habitat conditions, and analysis. It is the responsibility of the field crew and the Project Manager to follow the Photograph standard operating procedure available through the Klamath Network intranet or by directly contacting the Network Data Manager.

Field Computers

Field computers such as personal digital assistants (PDA), palmtop computers, and tablet personal computers (PC) can be used to improve data entry efficiency, data quality, and reduce time constraints. While using field computers, data should be downloaded nightly unless otherwise stated during the planning process. Batteries should be checked, replaced or charged on a daily basis prior to going into the field. If possible, a spare battery should be kept with the computer while in the field. Hardcopy datasheets should be carried with the computer in case failure of the device occurs while in the field. Benefits and disadvantages of field computers include:

Advantages:

- Improved data accuracy by reducing the number of data transcription errors from field datasheets.
- Possible inclusions of a database with pick lists and domain values to reduce errors.
- Ability to be downloaded directly to a desktop PC, decreasing data entry time.
- Lessened risk of misplacing datasheets.
- Ability to utilize GPS and GIS technology in association with a relational database, improving the accuracy of spatial data.

Disadvantages:

- Are affected by environmental constraints such as moisture, heat, and dust.
- Can have limited memory and battery power.
- Can be heavy or fragile; special care needs to be taken while conducting intense field work. Devices should be “ruggedized” prior to conducting field work. Ruggedization may include a waterproof hard carrying case, throwaway screen protectors, a sunlight readable screen, shock and dust resistant hardware, and hardwired supporting hardware.
- May require additional programs to create data entry forms and databases.
- Can be difficult to read in the field due to weather and environmental conditions.

- Can risk losing a substantial amount of data if not downloaded or backed up on a regular basis. All data collected electronically for a Klamath Network-supported project must have a back up made on-site and should be downloaded nightly unless stated otherwise.

5.1.2 Field forms

Hardcopy or electronic field forms should be designed to the following specifications:

Hardcopy:

- Hardcopy forms should mimic the electronic form when applicable.
- The entire form should be completed at the site and double checked (if possible, by a crew member who did not enter the data) prior to leaving the site.
- All handwriting will be printed and legible.
- If a change is made to the field form after leaving the site, a single line will be drawn through the data with the corrections made next to the error and initialed by the crew member making the correction. An additional sheet may be used to record the correction but it will need to be stapled to the original datasheet.
- Paper and writing devices should be able to withstand the environmental conditions of the project area. Acid-free paper should be used to prevent fading and subsequent loss of data. In addition, "Rite in the Rain" paper should be used to prevent data loss from moisture.
- Datasheets should be bound during use to prevent the likelihood that one or more sheets become separated or lost from the rest. Datasheets should be numbered and a log kept that records unused or missing datasheets.

Electronic Form:

- Electronic forms should match the hardcopy field form.
- Electronic forms should be kept as simple as possible. Do not include pictures or designs. Keep the forms clear and easy to read.
- Pick lists and auto populated fields should be utilized whenever possible.
- Domain values should be set to prevent non-valid data.
- The entire form should be completed at the site, and double checked (if possible by a crew member who did not enter data on the field form) prior to leaving the site.
- Data entered into the forms should be downloaded nightly unless otherwise determined during the planning phase.

5.1.3 Remote Sensing and GIS

Remote sensing and GIS are powerful tools that the Klamath Network will use to help provide information for vital signs monitoring and inventories. There is a large variety of data available and consideration needs to be given to the following:

- Project needs

- Accuracy and resolution
- Frequency of measurement
- Cost
- Licensing for public use
- Ortho-rectification needs
- Availability

In addition, there is much variation among the different types of data and imagery. Complete documentation for GIS and remote sensing data will be required prior to dissemination or use in analysis. For GIS data, every attempt will be made to use the most accurate information available. The Klamath Network currently (as of 12/1/2006) has a contract with SOU to provide base cartography for each park. GIS layers will be made available to the parks via the National I&M NPS Data Store. As a mandated requirement, any data posted at the NPS Data Store must be accompanied by FGDC compliant metadata.

5.1.4 Legacy Data

Data acquisition has occurred in all Klamath Network parks since their establishment within the National Park Service through inventories, monitoring, and scientific research. To capture this information, the Klamath Network started data mining efforts to catalog the natural resource information held at each park. The cataloging of research and management projects conducted at each park will help preserve the institutional memory and allow future studies to build upon past projects.

During the first phase of the data mining project, we concentrated our efforts on six taxonomic groups: amphibians, birds, fish, mammals, reptiles, and vascular plants. Within these groups, we found documentation to support a species list, located documents with species abundance and distribution, and used the documents to populate the NatureBib bibliography and NPSpecies databases. In Phase II, we expanded our criteria to also document references from the other inventory categories and to document datasets using the I&M Access database, Dataset Catalog. If enough information about the dataset is available and the dataset can be incorporated into the Klamath Network monitoring project, Federal Geographic Data Committee (FGDC) compliant metadata will be created using NPS Metadata Tools. Data with spatial components that are not already in GIS will be converted into GIS, if appropriate and enough spatial information is available. Lastly, the data will be incorporated into the Klamath Network Natural Resource Database if the data are relevant for vital signs monitoring projects.

5.1.5 Data Entry

Data entry consists of entering the data into an electronic format or transferring data from a field collection device to a desktop computer located in a stable environment. Procedures for data entry and download will be designed on a project-by-project basis and are dependent on the data collected, the equipment used, and the methodologies applied. Methods will be outlined in a data management SOP for each protocol.

Databases

The Klamath Network will take advantage of databases already designed for the purpose of a given project when possible (e.g., MARINE, STORET). For databases already developed, the Klamath Network will create a uploading process to incorporate the data into the Klamath Network master database. The master database will store data for all vital sign projects. If a database has not been developed, we will utilize the Klamath Network Natural Resource Database as described in Chapter 3. It will be the responsibility of the Data Manager to tailor the front-end component of the Klamath Network Natural Resource Database for each project.

Training

It is the responsibility of the Project Manager and Crew Leader to make sure all crew members are trained in proper data entry, data management protocols and procedures prior to starting a project. Each crew member needs to understand how to complete the hardcopy and electronic field forms. The Crew Leader will assess crew member's techniques throughout the project to determine if additional training is needed. It is the responsibility of the Project Manager to transfer completed data to the Data Manager. However, it would be worthwhile to train one of the crew members or the Crew Leader in this process to act as a backup.

Reliability, Accuracy, and Timeliness

Directors Order 11B states "All information will be accurate, timely, and reflect the most current information available. Where appropriate, it will provide users with additional documentation or with method(s) to access supporting documentation by reference (e.g., citations) or by electronic means (e.g., 'links')." All data will be entered and QA/QC in a timely manner as determined in the planning phase of the project. A data entry and backup schedule should be implemented prior to collecting data. Unless stated otherwise, data entry will occur each week. It is the responsibility of the field crew to make sure all data collected during the week is entered and documented prior to going into the field the following week.

Unless stated otherwise, data entry will occur each **week**

Data Verification

Data verification is the process of ensuring the data entered into a database mimic the data recorded on the hardcopy field form and data loggers. Verification procedures will be outlined on a project-by-project basis by the Data Manager and Project Manager. In general, it is the responsibility of crew members to enter and verify the data.
If possible, crew members should adhere to the following process for data entry:

- All attributes should be populated prior to leaving a site.
- One crew member should read the information while the other crew member enters the data.

- Each crew member should double check the entered record prior to moving to the next record.
- If using hard copy forms, data should be entered into the designated databases on a weekly basis unless determined otherwise during the project's planning phase. Once all records have been entered for that week, forms based on the database should be printed and compared to the field forms.
- Records should be saved to a backup source determined in the project's planning phase.

The Project Manager will check a predetermined number of records to ensure accuracy of the data entry. The Data Manager will make every attempt to construct automated queries and tallies to help crew members and Project Managers verify the data.

5.1.6 Changes to Protocols and Procedures

While the Klamath Network will make every attempt to use protocols and standard operating procedures that have been peer-reviewed and thoroughly tested it is estimated that some protocol alterations will occur over time. It is also expected that many of the changes will occur during the first five years after project implementation. However, over the long-term, adjustments in technology, methodologies, or project goals may require us to make additional modifications to the protocol and standard operating procedure methods. The Project Manager will work with the Network Coordinator and Data Manager to determine the best methods for protocol adjustments. If significant changes are needed or intended, the protocol may be reevaluated by the Regional I&M Coordinator for possible peer review.

5.2 Non-Programmatic NPS Data

The Klamath Network will utilize data gathered by the NPS at the local, regional and national level as the need arises. This data can be used for, but not limited to: creating baseline data, monitoring site selection, ancillary data, protocol development, ground truthing, and quality control. The Data Manager will work with NPS personnel to determine what data are available and how they can be incorporated into the Klamath Network projects.

5.2.1 Park Data

In 2004, the Klamath Network initiated a data mining project to inventory the natural resource information currently stored in the Klamath Network parks to preserve institutional memory, allow future studies to build upon current and past projects, and to support I&M planning. This data mining project is planned to run through FY 2007. The intent of the data mining activities is to document the what, where, when, who and how's of the data. It is not the objective of the Network to store park datasets. However, if Data Miners determine that a dataset could be utilized in the monitoring phase of the program that dataset will be copied and stored in the Network system. Original copies of all information found during the data mining process will remain at the parks where they

currently reside. A catalog of all the information will be created and entered in NPSpecies, NatureBib, NPS Data Store, and Dataset Catalog, as appropriate.

The Klamath Network will work with each park to develop a method to keep the Network informed on natural resource projects occurring within the parks. It will be the parks' responsibility to enter data into the NPS databases for these projects. However, the Network will assist the parks by providing training, develop streamlined data entry documents, and offering technical support and guidance as needed.

5.2.2 Regional and National Programs

There is an assortment of regional and national programs that will help provide long-term benefits to the Klamath Network and the parks within the Network. It is the goal of the Network to document our work within these programs as time and funding allows. The Klamath Network will also utilize these programs to provide information, gather, and organize data, and transfer information to the Network parks. Some of the programs that provide a good resource for natural resources monitoring information include:

- Air: The Air Resources Division, in partnership with parks and others, works to preserve, protect, enhance, and understand air quality and other resources sensitive to air quality in the NPS. The NPS Air Resources Division (ARD) provides spatial and tabular air quality data through their website at: http://www2.nature.nps.gov/air/index.cfm.
- Exotic Plants: Exotic Plant Management Teams (EPMTs) collect and maintain data displaying the presence of exotic species within the parks. This information along with treatment information can be found in the Alien Plant Control and Monitoring Database (APCAM) at: http://www.nature.nps.gov/biology/invasivespecies/.
- National I&M Program: The Klamath Network will utilize databases developed by the National I&M Program to disseminate and obtain data related to GIS, parks species, bibliographic information, and metadata.
- Climate: The first climate inventory was done by the National I&M Program to compile baseline climate data useful to NPS biologists, hydrologists and resource managers. The inventory integrated data from more than 6,000 precipitation stations and 4,000 temperature stations across the conterminous United States to develop maps with relevant climate variables. The inventory produced both GIS-based and tabular products; these are now available for most NPS units. Data in the climate atlas can be downloaded from the original Natural Resource FTP site at: http://science.nature.nps.gov/nrftp.
- Geology: The NPS Geologic Resources Evaluation (GRE) Program is a cooperative endeavor to implement a systematic, comprehensive inventory of the geologic resources in NPS units. Geology information is available though the NPS Data Store webpage.
- Water: The National Hydrography Dataset (NHD) is the NPS standard for spatial hydrography data. The NPS Water Resource Division (WRD) provides assistance with water quality data management by maintaining the NPSTORET database to

transfer NPS data to the WRD database. The database is found at: http://www.nature.nps.gov/water/waterquality/index.cfm.

- Soils: Soils information is provided by the Natural Resource Conservation Service (NRCS) and maps for the completed parks can be found at http://science.nature.nps.gov/im/inventory/soils/index.htm.

5.3 Non-Programmatic External Data

In the information age there is a staggering wealth of information available from a diversity of individuals, agencies, counties, universities, and private organizations to name a few. Since the vast amount of information would overwhelm the programs modest storage capabilities, the Network will access information for specific needs as they arise. When utilizing external data, the Klamath Network will require that complete documentation of any dataset is obtained prior to using the data for project design, analysis, or publications.

5.3.1 Data Processing

There are innumerable locations where the Klamath Network may obtain data to help with the vital signs monitoring program. It is important to process that information so it can be integrated with other data managed by the Network. The degree to which the data can be used will be proportional to the accuracy and completeness of the metadata. It is the Data Manager's duty to work with the Project Manager and GIS Specialist when determining the value of a dataset. In addition, it is the Data Manager's responsibility to convert the acquired data into a format that is compatible with data managed by the Network. Generally, data obtained from non-Network sources and used in project development, data analysis, or dissemination will be managed in the following manner:

- GIS data managed by the Network will be converted to the spatial reference NAD84 Zone 10.
- Park related biodiversity data and citations will be entered into the national I&M databases.
- Reference material will be stored in the Klamath Network electronic library.
- Hard copy forms and notebooks will be stored in locked field cabinets and transferred to an electronic format (PDF) when possible.

- Datasets should be converted into the Klamath Network Natural Resource Database format if possible.
- Data will be subject to the Data Naming and File Storage SOP.

6. Quality Assurances and Quality Control

One of the most important aspects of data management is ensuring that data (and metadata) are of known quality. The level of quality will vary and may depend on purpose, budget, available equipment, and personnel. Understanding the level of accuracy of a given dataset will allow the user certain levels of confidence when applying the data to management purposes. In order to detect a change in natural resource trends or patterns over time, the acquired data needs to be of high quality with minimal amounts of error or bias. Data of inadequate quality can lead to loss of sensitivity which may result in misinterpretation of the information.

While it is always the goal of the Klamath Network to obtain 100% accurate data, this is a nearly impossible task. Errors inevitably occur from a range of sources and must be

anticipated, minimized, and corrected where possible. The Network will apply well-conceived and proven QA/QC methods to ensure that data are held to the highest possible standard of accuracy and precision possible.

Quality assurance is the planned and systematic pattern of all actions necessary to provide adequate confidence that the project optimally fulfills expectations (i.e. that it is problem-free and able to perform the task for which it was designed). Quality control should be independent of the collection procedures and is the process of examining the data after it is produce to make sure it is in compliant with data quality standards.

6.1 Data Quality and the National Park Service

In 2001, Congress directed the Office of Management and Budget to issue federal government-wide policy and procedure guidelines to ensure and maximize the quality, objectivity, utility, and integrity of information disseminated by the federal government (Public Law 106-554; HR 5658). The following definitions apply:

- Quality – is an encompassing term including objectivity, utility and integrity.
- Objectivity – Whether disseminated information is being presented in an accurate, clear, complete and unbiased manner. In addition, objectivity focuses on ensuring information is accurate, reliable, and unbiased.
- Utility – Refers to the usefulness of the information towards its intended users, including the public.
- Integrity – Refers to the security of the information, insuring the information is protected from unauthorized users.

In 2002, Office of Management and Budget implemented these guidelines through a notice to the Federal Register and in return the NPS issued Director's Order (DO) #11B to comply with these requirements. Beyond meeting the guidelines initiated by Office of Management and Budget, DO#11B discusses information standards related to reliable data, accuracy of data, and timeliness of the data. It continues to state that these standards will not only be applied to data collected by the NPS, but also to any non-NPS information the NPS relies upon for analysis, dissemination, or decision making.

6.2 Goals and Objectives for Quality Assurances

Careful consideration should be given when determining the quality of the data as defined in DO #11B needed to meet project goals and objectives set forth during the planning phase of a project. The level of data quality required will depend on the vital sign being monitored, the selection of standard operating procedures, and the sampling protocol methods. It will be the responsibility of individuals participating in the project to ensure QA/QC processes are followed.

6.3 Roles and Responsibilities

As discussed in Chapter 2, nearly every person involved in a Klamath Network project will have some responsibility towards data management. For all Klamath Network projects, the largest responsibility to follow data QA/QC procedures falls on the Network Data Manager, GIS Specialist, Project Manager, Crew Leader, and the field crew. Specific roles and responsibilities include:

6.3.1 Data Manager

- Creates policies, guidelines, and standard operating procedures to ensure data quality.
- Designs, implements, supports and manages database systems for long-term monitoring projects, inventory projects, and various other I&M activities. Makes sure databases support quality data through quality assurance protocols.
- Provides training and technical assistance to field staff on data QA/QC, protocols and methodology.
- Evaluates data collected prior to incorporation into a master database or dissemination to other users.
- Ensures all documentation accompanies data as collection occurs.
- Makes sure each person working on a project understands their roles and their responsibilities towards data management while in those roles.

6.3.2 GIS Specialist

- Develops procedures for field collection of spatial and GPS data and techniques.
- Documents data in compliance with FGDC / NBII metadata standards.
- Establishes and implements procedures to protect sensitive spatial data according to project needs.
- Provides training and technical assistance to field staff on QA/QC, protocols and methodology.
- Provides efficient access to spatial information via the web, national I&M databases, and direct contact.

6.3.3 Project Manager

- Works with the Data Manager and GIS Specialist to develop, document, and implements standard operating procedures for field data collection, entry, QA/QC procedures, metadata documentation and data transference.
- Supervises and certifies all field operations including training for data collection and equipment use, data management, and personnel management.
- Documents all field activities that relate to data management.
- Works with the Data Manager and Network Coordinator to determine workload priorities, timelines, summaries, final reports, and deadlines.
- Serves as point of contact (POC) for all issues related to data collection.

6.3.4 Crew Leader

- Works with the Project Manager to train field crews in data collection, QA/QC methods, and equipment use and maintenance.

- Verifies and validates all data following methods established during the planning phase of a project prior to transferring the data to the Project Manager.
- Completes logs for training, method change, and datasheet documentation.
- Works with field crews to collect and transfer data.
- Stays aware of and follows established protocols and procedures for data collection and management.

6.3.5 Crew Members

- Collect data and complete verification and validation methods.
- Under the guidance of the Crew Leader, stay aware of and follow established protocols and procedures for data collection and management
- Work closely with the Crew Leader and Project Manager to determine data quality issues.
- Study and master methods to operate and maintain field collection equipment, including instrument calibration, data entry, error checking, data download, and data transfer.

6.4 Methods for Reducing Errors in a Project

A majority of the errors associated with data occur during the project's data collection and data entry phase. There are several methods and techniques the Klamath Network requires field crews to follow while working on a project to help reduce the opportunity for errors. It is important to note that not all of the following methods can be applied to every project. The Data Manager and Project Manager will coordinate and determine which methods are best suited for the project.

6.4.1 Data Collection

Ensure that field crews are properly trained

The Data Manager and Project Manager will work closely to determine protocols and standard operating procedures for each project. It is the Project Manager's responsibility to make sure field crews are aware of and follow those standards. In addition, it will be the Project Manager's responsibility to make sure all crew members are adequately trained in data collection methodologies and equipment use. For larger projects where crew turnover is expected, a training manual is recommended. A log should be kept outlining the training sessions each crew member attends and should be transferred to the Data Manager at the end of each field season.

Calibration and maintenance of equipment

It is important to obtain the most accurate data possible while in the field. Field technicians should be familiar with calibration and maintenance requirements of all equipment. Consult the equipment manual for suggested calibration times and methods. A log needs to be kept of calibrations times and dates and should be stored with the data.

A copy of this log will be transferred to the Data Manager at the end of the field season along with the data and metadata.

Supervision

Periodic checks of data collection techniques used by the field crews should be conducted to make sure they fully grasp and have not strayed from protocols. Random checks of the data should be conducted by the Project Manager to make sure methodologies are followed and equipment is used properly. The schedule of checks should be based on a schedule determined during the planning phase of a project.

Log book

It is the responsibility of the Project Manager to transfer all log books to the Data Manager at the end of each field season. A log book should be kept that documents any major decisions being made or events that have occurred to the protocol, standard operating procedures, or guidelines. Another log should be kept documenting the training each member of a project receives. In addition, a log should be kept of all equipment being used and calibration times for that equipment. These log books should record the event, date, and time in a manner that can be used to adjust the databases, methodologies, or standardized reports.

6.4.2 Data Entry

Accuracy and Timeliness

As stated in DO#11B, *"All information will be entered accurate, timely, and reflect the most current information available."* All data will be entered and QA/QC in a timely manner and a backup schedule will be implemented prior to collecting data as defined during the planning phase of a project. Data entry should occur on a regular schedule defined prior to the start of a project. When possible, data entry should be conducted on a weekly basis unless determined otherwise. In no circumstances should data entry be left until the end of a project.

In **NO** circumstances should data entry be left until the end of a project.

Hardcopy datasheets

All projects will have standardized datasheets created by the Project Manager and Data Manager. Datasheets will clearly identify the data that needs to be collected, incorporate pick lists when appropriate, be designed to mimic the electronic database entry interface when applicable, and include as much preprinted information as possible. At no point in a project should a field notebook be used as a replacement for a datasheet. At the end of the field season, after validation and verification of the hardcopy datasheets, the Project Manager will transfer the datasheets to the Data Manager where they will be scanned and stored at the Klamath Network in a PDF format.

It is important that data entry forms are easy to use, once complete can be read by most people, and clearly communicate the information to the reader. Data forms should adhere to the following:

- The entire form should be completed at the site and double checked (if possible, by a crew member who did not enter data on the field form) prior to leaving the site.
- All handwriting will be printed and legible. When possible, another crew member should check the datasheet for legibility prior to leaving the site. If another crew member is not available, the Project Manager should check the datasheets on a predetermined schedule to ensure they are legible.
- If a change is made to the field form after leaving the site, a single line will be drawn through the data with the corrections made next to the error (or on an additional sheet if more room is needed) and initialed by the crew member making the correction.
- Paper and writing devices should be able to withstand the environmental conditions of the project area. Acid-free paper should be used to prevent fading and subsequent loss of data. “Rite in the Rain” paper should be used to prevent data loss from water damage. Pencils should be used instead of ink pens.
- Datasheets should be bound during use to prevent the likelihood that one or more sheets become separated or lost from the rest. Datasheets should be numbered and a log kept that records unused or missing datasheets. This log needs to be transferred to the Data Manager at the end of the field season.

Databases and electronic forms

If possible, electronic devices should be used to collect field data. The use of handheld devices decreases the need for manual data entry from field forms, which in turn reduces errors related to transcription. In addition, when using an electronic database or spreadsheet pick lists, domain values, and specialized formats will be used to reduce the potential for data entry errors. When using electronic devices such as GPS units, data loggers, laptops, or PDAs:

- Complete documentation of the hardware and software used to collect the data should be included in the metadata.
- Devices should be downloaded daily unless another schedule has been predetermined during the project’s planning phase.
- Batteries should be checked and devices should be adequately charged prior to going into the field. If possible, a spare battery should be carried into the field.
- Routine inspections of devices left in the field (e.g., data loggers) should occur as necessary. Calibrations of field equipment should follow the recommendations in the equipment user manual.
- Field equipment can be fragile and every attempt to make them ruggedized should be made prior to going into the field.

Using electronic methods to collect data that includes a database and electronic forms are reliable techniques to reduce data entry errors. When conducting electronic data collection, follow these steps:

- Electronic data entry forms should be similar to the field forms in an attempt to reduce errors.
- Databases and electronic forms will be designed using a pick list, domains, and auto-filled fields to reduce errors associated with manual data entry.
- Data will be entered into a blank database where validation and verification will occur prior to being incorporated into the master database.
- Access restraints will be incorporated to prevent users from making unwarranted changes.
- When possible, users will be prevented from closing out a record if all data has not been entered.

Data editors

If possible, two crew members should enter the data into the database. One crew member should read the information while the other crew member enters the data. Each crew member should double check the entered record prior to moving on to the next record. Not only will this act as a check for the quality of the data, but it will also speed up the data entry process. Crew members will need to follow data verifications procedures outlined during the planning phase of the project.

Data verification

Data verification is the process of ensuring the data entered into a database mimic the data recorded on the hardcopy field forms and data loggers. Verification procedures will be outlined on a project-by-project basis by the Data Manager and Project Manager. In general, there are four methods that can be used to conduct proper data verification.

- Visual review at data entry. This method should always be used when entering data. In this method, the technician verifies each record after input. Records entered into the databases are compared to the data on the hardcopy datasheets and errors are corrected immediately.
- Visual review after data entry. After the data has been entered, all records are printed out and compared to the original values. Printed forms should be in the same format as the datasheets and database form. Errors need to be marked on the form and then corrected in the database.
- Duplicate data entry – Data entry is done as normal. However, a predetermined random number of records are entered into the database and into a blank database. A database query is then used to compare the records and report any mismatches. This method is more time consuming, but it gives an accuracy measurement of the data entry.
- Review – After follow the processes outlined in #1-3 above, it is the Project Manager's responsibility to review a predetermined subset of records that have

been entered into the database and compare them to the original hardcopy forms. A timeline should be developed during the project's planning phase to outline the number of records that will be checked and a timeframe as to when they will be examined.

Data Validation

While data verification can be completed by someone with little to no knowledge of the data, data validation requires a reviewer to have extensive knowledge on what the data mean and how they were collected. Data validation is the process of reviewing the finalized data to make sure the information presented is logical and accurate. The accuracy of the validation process can vary greatly and is dependent on the reviewer's knowledge, time, and attention to detail. General data validation procedures include:

- Data entry application programming. When possible, filters for illegal data will be used to prevent data being entered that exceeds its logical value (e.g., 6m vs. 60m diameter tree). It is important to note that not all fields have appropriate domains and it will be the responsibility of the Project Leader to examine these fields for erroneous data.
- Outlier detection and review. An outlier is an unusually extreme value for a variable, given the statistical model being used to analyze the data. It is important to note that not all outliers are a result of data contamination; they may be indicators of important thresholds or extremes in variation of the parameter of interest. Statistical tests such as Grubbs' test and regression mapping will be used to examine the data for outliers (Michener 2000). Depending on the analysis methodology, outliers may not need to be removed. A determination will need to be made to define what is considered an "unusually extreme" value indicating data contamination or an environmental aberration that clouds the interpretation of the field measurement. Generally, non error-associated outliers should be flagged and retained, allowing those conducting data analysis to make determinations about inclusion or rejection.
- Review of what makes sense. The Crew Leader and the Project Manager should be intimately familiar with the types of data being collected, including expected data ranges. The individuals in these roles should review the tabular data to make sure it appears logical. GIS data should be plotted and examined to determine the accuracy of the spatial locations.

Data Quality Review

As the Klamath Network continues to develop its Data Management Program, it will be important to constantly review and update our data management procedures. During any project managed or funded by the Klamath Network, we will:

- Work with the Project Manager and Crew Leader to examine current QA/QC procedures, and if needed, updated or change those procedures. A log will be kept

to record any major or minor revisions to the data management procedures of a project.

- Conduct random spot checks of Klamath Network projects to make sure they are conforming to all standards and protocols. If problems occur, the Data Manager will report those problems in writing to the Project Manager and Network Coordinator. It is the responsibility of the Project Manager and Network Coordinator to correct the problem.
- Collect evaluation forms on a seasonal basis from field crews to determine the need for improvement in data management or training associated with data management. To confirm processes are clear and useful the Data Manager will work with the Project Manager and field crews to make sure everyone is comfortable with all data management processes.

Quality control and assessment procedures, along with a statement assessing the overall quality of the data, will be included in the metadata for each project. For additional documentation procedures, see Chapter 7.

6.4.3 Version Control

Versioning is the process of documenting the temporal integrity of files as they are being altered. Long-term projects tend to outlive current staff, technology, and in some cases, the methodologies that were originally developed for the project. As one updates the documents, spatial files, and databases that were developed for a project, it is important to be able to trace the changes of those products over time. More importantly, because the products are changing, the editor must have a way to communicate to the project staff which product is the most up-to-date. Through versioning, an individual can quickly determine which product they should be utilizing to perform monitoring or inventory work.

Version Control Methods

There are several different methods that can be employed to represent the version of a document, GIS layer, spreadsheet, or database. Some of these include:

- Dates: Adding a date to the name of a file acts as a logical version control method. When using dates, they should be in the format: YYYYMMDD.
- Sequential Numbering: Adding a version number such as v1.0 or 001 can be used to keep track of the document's various versions. Care needs to be taken to ensure that everyone actively engaged in a project is aware of the most current version. In addition, a date should be included in the document to let the reader know when a version was changed.
- Including "Final": It can become difficult for a user to determine what the final version of a product is when there are multiple versions available. Including the word "Final" in the title is an easy way to declare a version as the most up-to-date. Care needs to be taken to change the name if you update the "Final" version.
- Version Control Software: Version control software such as Workshare Professional and Data Pump can be used track and synchronize multiple versions.

These software applications track changes made to the document, add comments related to those changes, and can easily retrieve each version of the document.

Unless stated otherwise, the Klamath Network will include a date and a version number (for easy readability) in the name of each file when version tracking is required. The date will be in the format YYYYMMDD and the version number will be in the format vX.Y where "X" is adjusted for each major revision and "Y" is increase for each minor revision.

Unless stated otherwise, the Klamath Network will include a date and a version number in the

7. Data Documentation

Quality data can be rendered nearly useless for long-term needs if it is not documented in a manner that lets future users understand its content, purpose, and limitations. A humbling but exciting reality is that long-term monitoring projects should be designed to outlive most of the personnel currently working on the project. Consequently, metadata, (data about the data) are essential for future users and interpreters of the data. This is particularly true for those elements describing data quality and use which form the basis of making informed decisions regarding the fitness of a particular data source (Chrisman 1994). The metadata, at the very least, should reference locations of key information about a project, usually found in project tracking databases, protocols, reports, and field notes. As stated in Director's Order #19, *"The National Park Service also has a strong business need for excellent records management, since the*

mission of the NPS is to care for natural and cultural resources so that they are 'unimpaired' for future generations. This requirement for managing resources in perpetuity sets a high standard for record keeping, as no resources can be managed well into the future without complete records of how they were managed in the past."

7.1 Mandates for Documentation

The NPS GIS committee requires all GIS data layers to be described with FGDC standards and the NPS Metadata Profile. Executive Order 12906 directs the FGDC to coordinate the federal government's development of the National Spatial Data Infrastructure (NSDI). It calls for agencies to use the FGDC Content Standard for Digital Geospatial metadata (CSDGM) to:

- Contribute to a national geospatial data clearinghouse and use the clearinghouse to determine data availability prior to starting a new data collection project.
- Document datasets according to metadata standards and support public access to data.
- Cooperatively develop data content standards and other geospatial data standards as deemed necessary.

The FGDC Biological Data Profile contains all the elements of the CSDGM and incorporates additional elements for characterizing biological datasets. In addition, metadata conforming to the Biological Data Profile can be incorporated into the National Biological Information Infrastructure (NBII) clearinghouse.

7.2 Roles and Responsibilities

Chapter 2 discusses the overall roles and responsibilities of personnel working for the Klamath Network. A summary of the roles and responsibilities for documentation are listed below. It is important that each member of a project understands what his or her responsibility is towards data documentation. Proper documentation will make the data more accurate and useable. In addition, documentation of project activities will allow the Klamath Network to monitor changes to the project over time.

7.2.1 Crew Leader

- Documents requests for training, support tools, and protocol issues.
- Collects data and populates field forms and/or databases.
- Completes all data management log books.
- Prepares written documentation of changes to the project protocols or methodologies.
- Completes the data management survey prior to completing project duties.

7.2.2 Project Manager

- Works with the Data Manager to document data collection protocols and procedures.
- Provides datasheet, photograph, training, and project alteration log books.
- Develops metadata including, but not limited to, data dictionaries, QA/QC procedures, and data collection protocols.
- Develops progress and summary reports, publications, and annual reports.

7.2.3 Data Manager

- Provides support to staff in metadata development.
- Works with the Project Manager to document protocols and standard operating procedures.
- Checks metadata to make sure it is FGDC and NBII compliant.
- Documents all aspects of database development and use.
- Monitors Klamath Network staff to ensure documentation is occurring in a timely manner and reports issues to the Network Coordinator.
- Works with the Network Coordinator, Program Assistant, and Project Manager to update and complete the records in the project management database.

7.2.4 Program Management Assistant

- Works with the Data Manager, Project Manager and Network Coordinator to keep the project records in the project database current.
- Incorporates all photographs and associated metadata into the Klamath Network Photograph Database.
- Ensures that documentation for databases, maps, and project information accompanies any information posted on the Klamath Network internet and/or intranet websites.
- Follows all standard operating procedures, guidelines and the Data Management Plan.

7.3 Documentation Process

The overall goals of metadata creation are to develop a comprehensive document that explains enough about the project data to ensure they are useable for future personnel and the scientific community, and also to comply with FGDC and NPS mandates for federal projects. Metadata development begins at the start of every project; as the project develops, so do the metadata (Figure 9). Within the sideboards set by the program and federal requirements, the process of metadata creation will vary depending on goals and objectives, funding, and scope of the project. It is the responsibility of the Data Manager to set forth the metadata requirements and the process used to create the metadata. Listed below are some of the general methods of metadata documentation the Klamath Network intends to follow for all I&M projects.

7.3.1 Planning Phase

Most of the metadata creation will begin in the project's planning phase. During this phase, the Data Manager will work with the Project Manager to outline the timeframes and methodologies for metadata creation. The Klamath Network is currently (as of 12/15/2006) in the process of developing a metadata SOP that defines what metadata products are required for a given project, how they are to be developed, and when they are due.

Project Tracking Database

It is the duty of the Program Management Assistant to work with the Data Manager, Project Manager, and Network Coordinator to create and update the records in the Klamath Network Project Tracking Database for each project. The project tracking database is used to record:

- Project name, tracking numbers, and project classification type
- Start date, target completion date, contacts, and associated parks
- Funding and permits
- Abstract, activities, and accomplishments
- Deliverables and projected dates
- General notes

Legacy Data

Data documentation is an old concept that has been gaining more recognition in recent years. Due to staff turnover, inconsistent funding, a preference for data collection, and a reluctance to allocate adequate funding and effort to data management, results from past efforts in parks are not readily available to guide I&M efforts. Although there is a wealth of knowledge from past effort in the Klamath Network parks, documentation of legacy data was often incomplete, making it nearly impossible to create FGDC compliant metadata for historic projects. Nonetheless, the Klamath Network will make every attempt to integrate legacy information into projects to help save time, provide high quality information, and prevent the "reinvention of the wheel." The degree of usefulness of legacy data for the Network will be directly correlated with the desired purpose, availability, and documentation of the data.

Wherever possible, the Klamath Network will convert existing metadata for any legacy datasets utilized by the Network into an FGDC acceptable format. If full metadata cannot be completed, the data will be entered into the Klamath Network incomplete Dataset Catalog stored on the Klamath Network server. While there are several uses for undocumented datasets in the development of a project, it is important to recognize that careful consideration of all information should be considered prior to being used in analysis or being disseminated to the public.

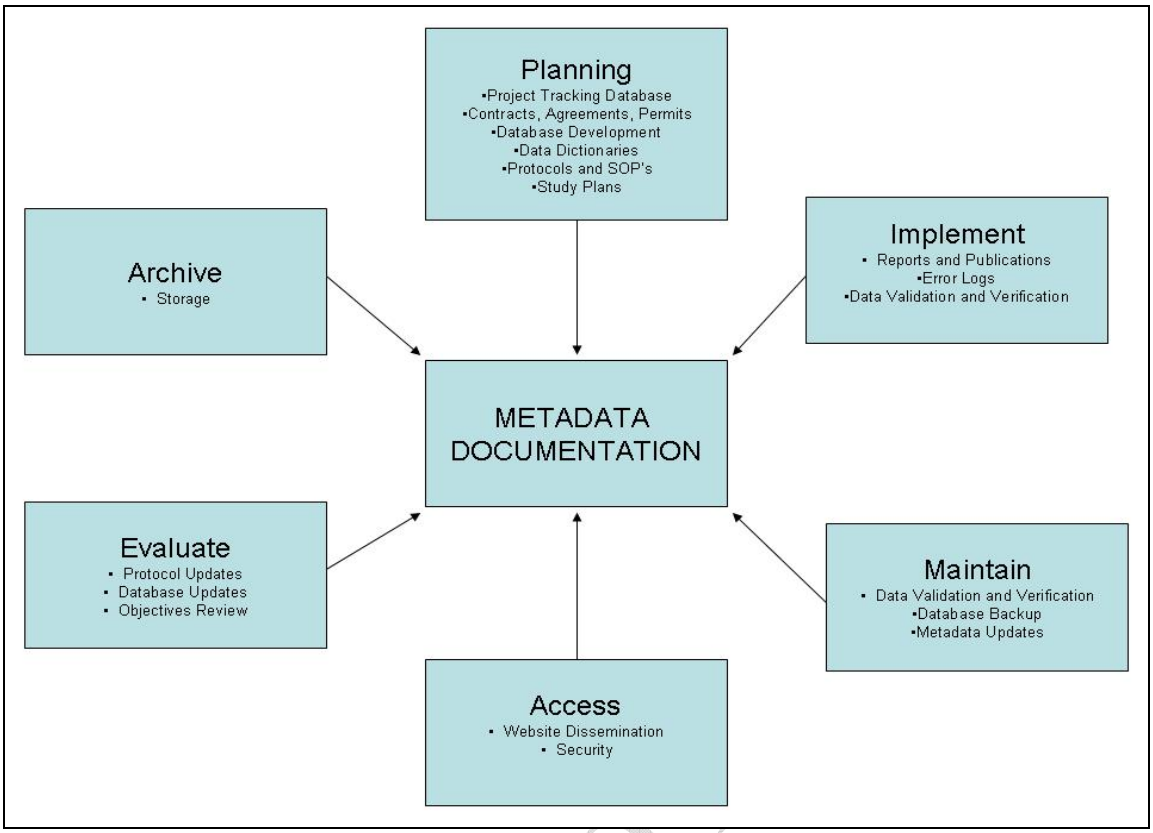

Figure 9. Metadata documentation activities throughout the various phases of the data lifecycle.

Project Database, Datasets and Forms

The Project Manager will work with the Network Data Manager and GIS Specialist to develop data dictionaries for all tabular and spatial datasets. The data dictionaries will be in a standard format and for each attribute will include: 1) table name, 2) field name, 3) field type, 4) field size, and 5) a short description of the data in the field. The data dictionaries will be used by the Data Manager to help develop the database and metadata. The metadata will include a description of all reports or forms that are incorporated into the database, a list of tables and queries with descriptions, and a list of all relevant QA/QC processes applied. Once data have been certified by the Project Manager (usually at the end of the field season); he or she will work with the Data Manager to complete or update the metadata.

Documents

Protocols, standard operating procedures, guidelines, contracts and agreements are great sources of information that will need to be examined to help populate a project's metadata for a project. It is the responsibility of the Project Manager to utilize all relevant documents to create the most detailed metadata possible.

7.3.2 Implementation Phase

During the implementation phase, it is important to document any changes that may occur to the sampling protocol, data management methods, personnel changes, or changes in equipment. It is also important to document dates of field equipment calibration and crew training. During this phase, field crews and the Crew Leaders should be initiating the validation and verification procedures outlined during the project's planning process.

Log books

During the implementation phase, the Project Manager is responsible for keeping logs of datasheets, special events, equipment, and training. Standard log forms can be obtained from the Data Manager. If using hardcopy datasheets, the sheets should be incrementally numbered and a datasheet log kept of missing sheets that describes the number missing and what happened to it/them. The special event log should be kept to describe any changes in the methods being used to collect the data. An equipment log should be kept to record the dates and times of changes to equipment (e.g., upgrades or calibration). The training log is used to record training the crew members received for data management, equipment use, and collection methods. These logs should be turned in with the data at the end of the field season.

Data Validation and Verification

It is the responsibility of the Project Manager and Data Manager to include data verification and validation procedures in the metadata. The Project Manager should include in the metadata the methods utilized to: enter data into the database, check the data after entry, and analyze the data to search for anomalies that may need to be removed. When developing databases, as discussed in Chapter 6, the Data Manager must make every effort to include validation measures in the database. These measures need to be recorded and incorporated into the metadata for each project.

7.3.3 Maintenance Phase

Not only is it vital to the Klamath Network Data Management Program that complete and accurate metadata be developed for each project, it is just as important that the metadata are kept up-to-date as the project develops. During the maintenance phase, all documents need to be reviewed, brought up to date, and exported to standardized formats.

Database Backup

Prior to the transfer of metadata (and data) to the Data Manager, it is the responsibility of the Project Manager to make sure metadata are being stored with the project data during backup procedures. Upon transfer, this responsibility is turned over to the Data Manager. The Project Manager must keep the Data Manager informed of any changes to the metadata once this transfer has occurred. These changes will be kept in a standard metadata log that will be provided prior to project implementation. Once the Data Manager has the data and metadata, they are required to follow the backup processes described in Chapter 10.

Storage

Once the metadata are complete, they will be transferred to the Network Data Manager, where they will be saved and parsed into varying levels of information (Table 7). The Data Manager will store the metadata in a project folder located on the Klamath Network server. Once on the Klamath Network server, the data will be transferred to the NPS Data Store. From the Data Store, it will be copied to the NPSFocus metadata clearinghouse, where it can be accessed by internet users (Figure 10).

Metadata Parsing

The Klamath Network will conform to FGDC guidelines and parse metadata into three levels of detail directed towards a variety of users (Table 7). All parsed metadata will be stored as an Extensible Markup Language (XML) and viewable or printable through the Klamath Network website.

Table 7. Metadata parsing strategy the Klamath Network will utilize to distribute metadata to a diverse audience.

Metadata Parsing	Purpose
Level 1 – "Manager Level"	Overview of the data so the user can quickly understand the purpose of the data.
Level 2 – "Scientist Level"	Same as level 1 with some additional details that allow the user to quickly assess the quality and usability of the product.
Level 3 – "Full Metadata"	Full documentation which will allow the user to completely understand the product.

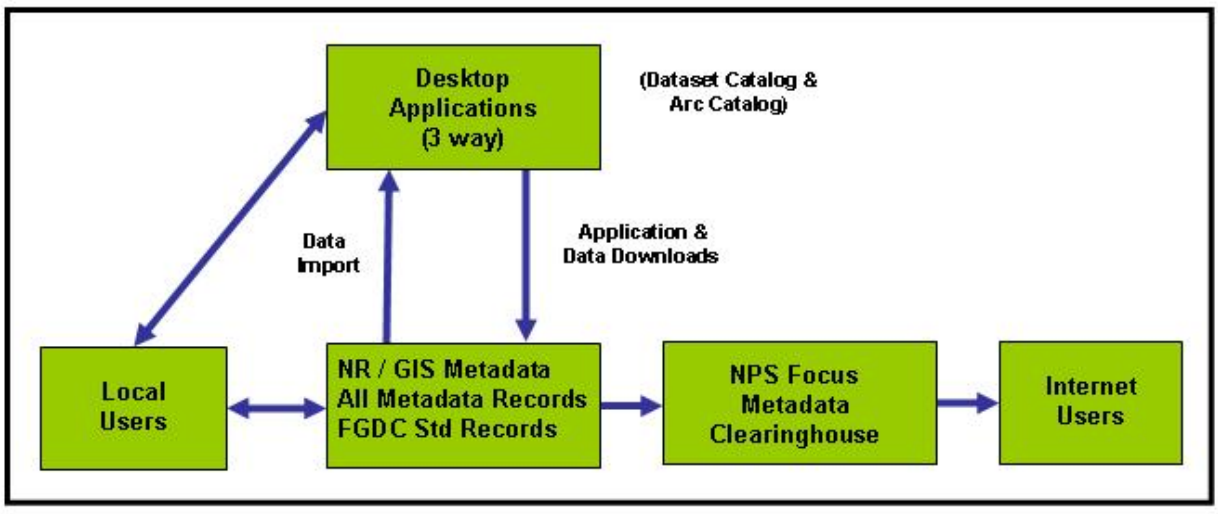

Figure 10. Process to store metadata at the national level.

7.3.4 Access Phase

The Klamath Network will utilize their internet and intranet websites and the NPS Data Store to disseminate information to the general community. Prior to dissemination, all information must be associated with FGDC compliant metadata (Chapter 8). It is the responsibility of the Data Manager to work with the Project Manager and park staff to determine the sensitivity of the data prior to posting. Constraints will be placed on sensitive data that prevents distribution to the public.

7.3.5 Archive Phase

It is the responsibility of the Data Manager to make sure all products archived or transferred to backup storage areas are complete and have associated metadata. As stated in Chapter 10, the Klamath Network will rely on SOU for all their backup and archiving processes.

7.3.6 Metadata Tools

There are various tools the Klamath Network will utilize to develop metadata that is FGDC compliant and includes the information in the Biological Profile. Some of these tools are:

Dataset Catalog

This database is a tool for keeping an inventory of and providing abbreviated metadata ("metadata lite") about a variety of natural resource datasets, from physical files and photographs to digital scientific and spatial data. The federal government requires that spatial data have fully FGDC-compliant metadata, but for non-spatial data, the Dataset Catalog provides a means for parks to keep an inventory of various data files, notebooks of field data forms, photographs, etc.

NPS Data Store

The NPS Data Store application manages and shares natural resource and GIS metadata and data generated by the natural resource and service wide GIS programs of the NPS. It was previously named the "Natural Resource and GIS Metadata and Data Store." To facilitate data dissemination to the public and throughout the NPS, the NPS Data Store application posts information to the NPS GIS Clearinghouse located in NPSFocus. The NPS Data Store is part of the NPS Metadata System and provides two functions: the NR-GIS Metadata Database and the NR-GIS Data Server. The NR-GIS Metadata Database is a repository of and search engine for metadata describing natural resource and GIS data. The NR-GIS Data Server hosts natural resource and GIS data (documented by the metadata in the NR-GIS Metadata Database) for download.

NPS Metadata Tools and Editor

The NPS Metadata Tools and Editor is a metadata management and editing application that implements two separate interfaces: either (1) as an extension within ArcCatalog versions 8.3/ 9.x, or (2) as a standalone desktop interface. The application is intended to be the primary editor for metadata that will be uploaded to the NPS Data Store. The NPS Metadata Tools and Editor application integrates with the NPS Data Store information system by producing XML metadata files based on the NPS Metadata Profile that can then be uploaded to the NPS Data Store application. Metadata editing is done with editing style sheets that transform a standard XML

metadata file into an editable record. The initial editing functions include those elements required for upload to the NPS Data Store and Biological Profile metadata elements.

USGS MetaParser

MetaParser is a command-line tool that tests metadata files against the FGDC Content Standard for Geospatial Metadata. MetaParser can be configured for other metadata profiles including the ESRI Profile and the NBII Biological Profile.

7.4 Non-Programmatic Data Documentation

Any data used in analysis or distribution by the Klamath Network will adhere to the same level of documentation as required for Klamath Network-collected data. It will be the responsibility of the Project Manager to collect metadata from the original entity for all data, prior to conducting analysis. Contracts or task agreements will need to stipulate that all data collected through them also include the submission of full metadata in a format determined prior to signing the agreement or contract. It is the Data Manager's responsibility to provided tools and methodologies to help program leaders develop and manage metadata.

7.5 Derived Data Documentation

It is inevitable that analysis of long-term monitoring data will produce derived data from datasets that have to be accurately documented. It is the responsibility of the Project Manager to create compliant metadata for all derived data that will be made available to individuals other than the Project Manager. In addition to the metadata that generally parallels project data derived data must include a data lineage that points back to the original dataset.

8. Data Analysis and Reporting

Raw data are a valuable resource, but until they have been analyzed and transformed into information, they are of limited use. As stated in the I&M NPS-75 document, one of the overall I&M goals is to "*integrate natural resource inventory and monitoring information into National Park Service planning, management, and decision making.*" To do this, the data must be converted into a format that is useable by a diverse number of individuals.

While the overall objective of the Klamath Network is to create information to be used by the Superintendents, Resource Chiefs, and GIS Specialists of each park, it is recognized that a large number of additional groups, including planners, project managers, resource specialists, interpreters, public, and the scientific community, will come to rely on the information we provide. To convey our information to these other groups, the Klamath Network will communicate our objectives and accomplishments through annual reports, technical reports, scientific publications, outreach brochures, and displays.

In this chapter, we discuss the methods by which data will be analyzed and converted into information. We will also discuss the various reports that will be used to present the information to the intended users.

8.1 Data Analysis

During the analysis phase of a project, the "raw data" are transformed into information that can be used to help understand the condition of the natural resources for a park within the Klamath Network. The overall goals of each project will vary, but in general, analysis will focus on three activities: 1) determining status and trends in the condition of the resources being monitored, 2) determining the correlations among resources and known stressors and exploring for abnormal conditions or impairments to the resource being monitored, and 3) measuring progress towards performance goals.

There are a nearly infinite number of analysis methodologies that can be undertaken with long-term natural resources datasets. Most of these fall into the following categories:

- Data reduction
- Data transformation
- Graphical analysis
- Univariate statistical analysis including conventional, descriptive, and nonparametric statistics
- Multivariate statistical analysis
- Spatial and temporal analysis

It will be the responsibility of the Project Manager working in conjunction with the Network Coordinator and Statistician/Biometrician to determine what combination of analysis methodologies are best suited for each dataset. The Data Manager will work with

network personnel to design or adapt data and database components to support the format necessary for analysis using GIS (e.g., Geodatabases) or statistical (e.g., SYSTAT, R, SPSS, PCORD) software. Table 8 outlines some general approaches we expect to use in analyzing monitoring data for our core vital signs.

Table 8. Statistical analysis that will be utilized to analyze the ten Klamath Network vital signs.

Vital Sign	Univariate Analyses	Multivariate Analyses	Spatial Analyses
Invasive Species	X	X	X
Whitebark Pine	X		X
Vegetation	X	X	
Bird Communities	X	X	
Water Quality	X	X	
Intertidal Communities	X	X	
Aquatic Communities	X	X	
Cave Entrance Communities	X	X	
Land Use Landcover			X
Cave Environment	X	X	

8.2 GIS Product Development

It is the responsibility of the field crew and ultimately the Project Manager to make sure that spatial data are collected, updated, and accurately documented. It will be up to the Project Manager and GIS Specialist to work together to determine the desired GIS products for each project.

The Klamath Network is currently (12/1/2006) developing an SOP for the proper use of GPS tools when collecting field data. This will be a detailed document describing the methods to be used when collecting GPS data utilizing the GPS units (Garmin V and Trimble GeoXT) provided by the Klamath Network. It is the responsibility of the Project Manager to train the field crews on the correct methods to employ when collecting GPS data.

Metadata for each product will be completed and updated prior to the start of a new field season. Metadata will be created by the Project Manager working with the Data Manager and GIS Specialist utilizing the methods listed in section 6.3. It is important to note that derived spatial data intended for analysis or dissemination must have associated metadata. In addition to standard metadata documentation, derived data must also include the name of the source data.

The Data Manager will work with the GIS Specialist to manage non-spatial project data in a method that it can be incorporated into GIS for spatial and statistical analysis when applicable.

8.3 Data Validation

Outlier detection, summary statistics, and exploratory analysis are three methodologies described in Chapter 6 that will be utilized for QA/QC processes in the project's analysis phase. It will be the responsibility of the Project Manager and Statistician/Biometrician to report to the Data Manager any validation issues discovered with the data. It will be the Data Manager's responsibility to work with the Project Manager to make sure the data have been correctly validated prior to entry into the master database.

8.4 Reports

Reports are the key mechanism the Klamath Network will use to keep all interested parties informed of recent findings, accomplishments, and general progress on each project. Annual reports will be used to regularly demonstrate the overall progress and future direction of the Network. Progress reports will be used to show the accomplishments of individual projects. Summary reports will be developed to calculate basic information that can be used to update the progress and annual reports. Analysis and Synthesis reports will be created on a 10 year interval and will be used to integrate results from all monitoring projects within and across all parks be and disciplines in order to interpret changes to park resources. All reports will be made available through the Klamath Network intranet and internet websites.

8.4.1 Project Summary Report

The Project Manager will work with the Data Manager to develop an automated summary report for each monitoring or inventory project. The summary report will be used to help update the annual report, progress report and Network websites. The project database will be designed in a manner that allows any user to run the summary report at any given point in time. At the end of each active field season, once the data have been integrated into the master database, the Data Manager will run and archive an official summary report.

8.4.2 Progress Reports

It is the responsibility of the Project Manager to provide a progress report that summarizes the annual accomplishments and the future direction of a project. Progress reports are only necessary when there has been some change with a project's progress. For example, if a vital sign is only sampled once every five years, then a progress report is only required once every five years for that vital sign. Progress reports should include annual accomplishments, future direction, and changes to the project. It is the responsibility of the Project Manager to work with the Network Coordinator in developing yearly project goals and objectives.

8.4.1 Analysis and Synthesis Reports

These reports can provide critical insights into resource status and trends, which can then be used to inform resource management efforts and regional resource analyses. This type of analysis, more in depth than that of the annual report, requires several seasons of

sampling data. Therefore, these reports are not written more frequently than every three to five years, for resources sampled annually. For resources sampled less frequently, or which have a particularly low rate of change, intervals between reports may be longer. An overview of anticipated Klamath Network analysis and synthesis reports is presented in Table 8. It is important that results from all monitoring projects within and across all parks be integrated across disciplines in order to interpret changes to park resources. This will be accomplished with a network synthesis report produced at no more than 10-year intervals. The role of analysis and synthesis reports is to 1) determine patterns/trends in condition of resources being monitored, 2) discover new characteristics of resources and correlations among resources being monitored, 3) analyze data to determine amount of change that can be detected by this type and level of sampling, 4) provide context, interpret data for the park within a multi-park, regional or national context, and 5) Recommend changes to management of resources (feedback for adaptive management).

8.4.3 Annual Report

Each year, the Klamath Network creates an annual report summarizing the accomplishments and future direction of the Network. This report includes short summaries of each active project the Network is supporting, budget information, personnel structure, protocol development, available documents, GIS information, and the status of the vital signs monitoring. Annual reports are developed by Klamath Network staff with the support of the BOD and the TAC. It is the responsibility of the Data Manager to make sure this report is available through the Klamath Network webpage.

8.4.4 Scientific Journal Articles and Book Chapters

This aspect of the program will be directed by the program managers, and is more at their discretion than previous reports. Publishing scientific journal articles and book chapters is primarily conducted to communicate advances in knowledge, and is a very important, widely acknowledged means of quality assurance and quality control, via the academic peer-review process. Scientific journal articles and book chapters produced by Klamath Network efforts are tracked by the Klamath Network monitoring program; new publications are listed as part of the Annual Administrative Report and Work Plan, which is sent to the regional and national offices each year. Additionally, all scientific journal articles and book chapters will be entered into the NatureBib database.

8.4.5 Interpretation and Outreach

Scientific information gained from monitoring programs usually requires a concerted effort to be translated for the general public. Through the interpretive programs, the Outreach Partnership with Southern Oregon University, the Crater Lake Science and Learning Center and park Natural History Associations, and The Klamath Network's own outreach vehicles, the I&M Program will work to disseminate its findings each year. Occasional, theme-based symposia will be organized by network staff to invite Principal Investigators working in the parks to present their monitoring results and discuss their implications. In the future, the Network plans to produce brochures and fact sheets regarding monitoring and its implications.

9. Data Dissemination

One of the overall objectives put forth to the I&M Program was to provide inventory and monitoring data and information in such a way that it can be integrated into NPS planning, management, and decision making. In order to accomplish this goal, the Klamath Network will strive to make sure data managed by this program are easily accessible, have been completely documented, and are secure.

9.1 Ownership

When working with multiple agencies, cooperators, and other organizations to collect and disseminate information, it is important to define the aspects of ownership prior to implementing a project. Deciding who the owner(s) of the data will be allows the project planners to determine where the information will be stored and duties will be placed, such as who will backup and archive the data, who has the overall responsibility of maintaining the data, and how scholarly publication goals can be accommodated. The Klamath Network relies heavily on partnerships, contracts, and agreements to collect information about natural resources. It is important that the owners of the data manage the data in a way that is complete and accessible to all participants. It is important to recognize that:

- All data and materials collected or generated using NPS personnel and funds becomes the property of the NPS.
- All research should be submitted for publication in a timely manner. In addition, authorship and formal acknowledgement should accurately portray those individuals and organizations who contributed to the project.
- Personnel must share information, data, and supporting materials whenever relevant. Two of several exceptions to this are sensitive information and personnel data.

9.2 Distribution and Mechanisms

Some of the potential distribution mechanisms the Klamath Network will utilize to disseminate information to the parks; scientific community and public are listed below.

9.2.1 Klamath I&M Network

Klamath Network websites

The Klamath Network intranet and internet websites will contain data management and reports and publication sections that allow direct assess to maps, reports, and publications. In addition, the Klamath Network will post draft documents and preliminary analysis, when applicable, on the intranet website. Prior to posting any documents, pictures, or data, all material will be screened for sensitive information.

Direct contact

The Klamath Network staff will make every attempt to be readily available to parks' staff, the scientific community, and various other potential users of the data managed by this Network. Individuals requesting data should contact the Data Manager by email or phone. The requester should send the following information:

- Name and position.
- Contact information.
- Date requested and date needed.
- Request including data needed, transfer method, format of data, and geographic extent.
- Intent of use statement.

9.2.2 National I&M Program

There are several databases managed at the national level that the Klamath Network will utilize to provide information to park staff and the public. Some of these are:

NatureBib

NatureBib is the master web-based database for scientific citations presented as bibliographic references. NatureBib merges a number of previously separate databases dealing with natural resource related topics like air, wildlife, geology, and paleontology. In addition, citations from individually maintained databases like NPSpecies and the Water Resource bibliography are imported to facilitate searching. NatureBib is one of the 12 Natural Resource Challenge inventories (bibliography) and complies with the Government Performance and Results Act (GRPA) goals. The site is designed to facilitate communication among researchers and make natural resource information more readily available and easy to locate.

NPSpecies

NPSpecies is the NPS database to store, manage, and disseminate scientific information on the biodiversity of all organisms in NPS units.

NPS Data Store

The NPS Data Store (previously known as the Natural Resource and GIS Metadata and Data Store application) manages and shares natural resource and GIS metadata and data generated by NPS. To facilitate data dissemination to the public and throughout the NPS, the NPS Data Store application posts information to the NPS GIS Clearinghouse located in NPSFocus. The NPS Data Store is part of the NPS metadata system and provides two functions: the NR-GIS Metadata Database and the NR-GIS Data Server. The NR-GIS Metadata Database is a repository of and search engine for metadata describing natural resource and GIS data. The NR-GIS Data Server hosts natural resource and GIS data for download.

Dataset Catalog

Dataset Catalog is a tool for keeping an inventory of and providing abbreviated metadata about a variety of natural resource datasets, from physical files and photographs to digital scientific and spatial data. The federal government requires that spatial data have fully FGDC-compliant metadata. For non-spatial data, Dataset Catalog provides a means for parks to keep an inventory of various data files, notebooks of field data forms, photographs, etc.

Biodiversity Data Store

This website provides access to documents, GIS maps, and datasets that contribute to the institutional knowledge of biological diversity, including the presence/absence, distribution, and abundance of organisms in NPS units throughout the United States and its territories.

9.2.3 Other NPS programs

NPStoret

The water quality component of the Natural Resource Challenge (NRC) requires that vital signs networks archive all physical, chemical and biological water quality data collected with NRC water quality funds in the STORET database maintained by the NPS Water Resources Division (WRD). To facilitate archiving data in STORET database, the WRD has been developing a series of Access-based templates (called NPSTORET), patterned after the Natural Resource Database Templates, for networks to use to enter their water quality data in a STORET-compatible format. Vital signs networks will send their data from NPSTORET or from their own data system following the NPSEDD specification to the WRD on an annual basis for quality assurance and upload into the WRD's copy of STORET and the Environmental Protection Agency's (EPA) STORET National Data Warehouse (Figure 11).

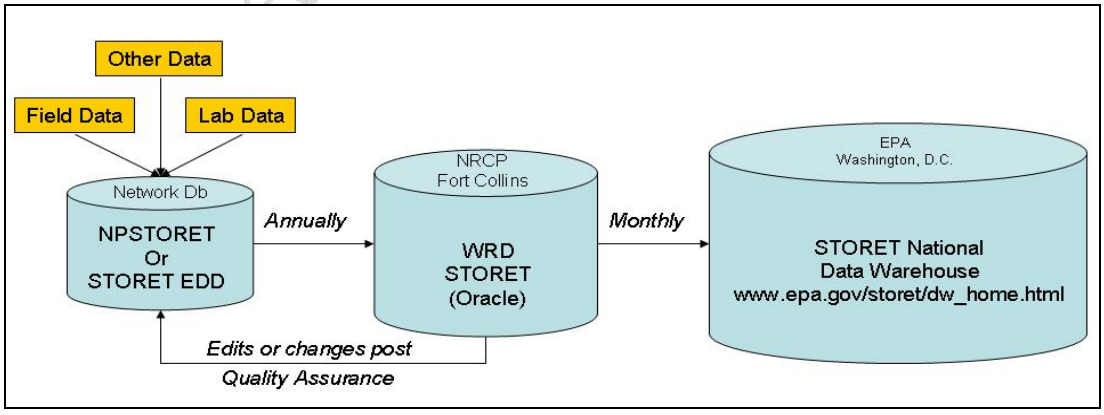

Figure 11. Simplified conceptual model of the Natural Resource Challenge vital signs water quality data flow.

9.2.4 Non-NPS Locations

Southern Oregon Digital Archives: Southern Oregon University has developed the Southern Oregon Digital Archives (SODA), funded by a grant from the Institute of Museum and Library Services. They have developed a digital library primarily from the SOU Library's rich collections of federal, state, and county publications. The library is concentrating its efforts on two collections of regional materials pertaining to the Southern Oregon Bioregion and the First Nations/Tribal Collection. The SODA Project was started in July 2001; public access to the SODA database began in October 2002.

9.3 FOIA and Sensitive Data

The Klamath Network recognizes the need to protect sensitive data from being released to unauthorized personnel. We will make every attempt to work with the Project Manager and park staff to define sensitive information for all datasets managed by the Network. In addition, the Network will follow any stipulations provided in the FOIA.

9.3.1 Sensitive Data

All data and information managed or funded by the Klamath Network will be screened for sensitive data prior to release. The Network Data Manager and Project Manager, in conjunction with park personnel, will work to determine what data and information needs restrictive access and what level of access need to be granted.

9.3.2 Freedom of Information Act

The Freedom of Information Act (FOIA; 5 U.S.C. 552), originally enacted in 1966, is a broad disclosure law, intended to allow public access to government records. FOIA requires federal agencies, including the NPS, to share information with requesting parties unless that information is covered by one of following nine exceptions.

- Specifically authorized under criteria established by an Executive order to (A) be kept secret in the interest of national defense or foreign policy and (B) are in fact properly classified pursuant to such Executive order;
- Related solely to the internal personnel rules and practices of an agency;
- Specifically exempted from disclosure by statute (other than section 552b of this title), provided that such statute (A) requires that the matters be withheld from the public in such a manner as to leave no discretion on the issue, or (B) establishes particular criteria for withholding or refers to particular types of matters to be withheld;
- Trade secrets and commercial or financial information obtained from a person and privileged or confidential;
- Inter-agency or intra-agency memorandums or letters which would not be available by law to a party other than an agency in litigation with the agency;
- Personnel and medical files and similar files the disclosure of which would constitute a clearly unwarranted invasion of personal privacy;

- Records or information compiled for law enforcement purposes, but only to the extent that the production of such law enforcement records or information (A) could reasonably be expected to interfere with enforcement proceedings, (B) would deprive a person of a right to a fair trial or an impartial adjudication, (C) could reasonably be expected to constitute an unwarranted invasion of personal privacy, (D) could reasonably be expected to disclose the identity of a confidential source, including a state, local, or foreign agency or authority or any private institution which furnished information on a confidential basis, and, in the case of a record or information compiled by a criminal law enforcement authority in the course of a criminal investigation or by an agency conducting a lawful national security intelligence investigation, information furnished by a confidential source, (E) would disclose techniques and procedures for law enforcement investigations or prosecutions, or would disclose guidelines for law enforcement investigations or prosecutions if such disclosure could reasonably be expected to risk circumvention of the law, or (F) could reasonably be expected to endanger the life or physical safety of any individual;
- Contained in or related to examination, operating, or condition reports prepared by, on behalf of, or for the use of an agency responsible for the regulation or supervision of financial institutions; or
- Geological and geophysical information and data, including maps, concerning wells.

In 1996, the Electronic Freedom of Information Act Amendments, or "EFOIA" updated FOIA to put more emphasis on proactive information delivery. FOIA establishes specific requirements for federal agencies to make information available electronically, particularly information that is of public interest. Under EFOIA, bureaus/offices were required to make certain “reading room” records created on or after November 1, 1996, available electronically by November 1, 1997. This requirement applies to records covered under section 552(a)(2) of the FOIA, including: final opinions rendered in the adjudication of cases; policy statements and interpretations adopted by the department that are not published in the Federal Register; administrative manuals and instructions affecting the public; and frequently requested FOIA documents.

9.3.3 Other Policies

In addition to FOIA, the NPS is directed to protect information about the nature of location of sensitive resources under the following:

- Executive Order No. 13007, Indian Sacred Sites, instructs agencies to accommodate access to and ceremonial use of Indian sacred sites on federal land by Indian religious practitioners, avoid adversely affecting the physical integrity of such sacred sites, and maintain the confidentiality of those sacred sites, where appropriate.
- National Parks Omnibus Management Act (NPOMA; 16 U.S.C. 5937) is interpreted to prohibit the release, under FOIA, of information regarding the nature and specific location of certain cultural and natural resources in the NPS.

- National Historic Preservation Act (16 U.S.C. 470w-3), prohibits the release of information about the location, character, or ownership of certain historic resources under certain circumstances. This law also identifies conditions under which the Secretary may release this information.
- Federal Cave Resources Protection Act, 16 U.S.C. 4304, prohibits making information concerning the specific location of any significant cave available under FOIA except under certain circumstances.
- Archaeological Resource Protection Act, 16 U.S.C. 470hh, prohibits the release, under FOIA or any other law, of information concerning the nature and location of certain archeological resources. This law also identifies conditions under which the Secretary may release this information.

9.4 Feedback

The Klamath Network will attempt to make sure information developed from the program has a wide distribution; we will be happy to accept additional comments on potential distribution location and tools. Request should be submitted to the Data Manager by email or phone and include:

- Requesters name and position
- Contact information
- Date
- Request details

10. Data Maintenance, Storage, and Archiving

This chapter will discuss the procedures the Klamath Network will follow to maintain, store, and archive digital and physical products managed by the Network. Physical products include, but are not limited to, hardcopy reports, aquatic samples, non-digital photographs, specimens, hardcopy datasheets, and emails. Digital products include, but are not limited to, raw data, digital images, electronic documents, and spatial data.

10.1 Digital Data Maintenance

The infrastructure the Klamath Network will utilize to maintain the data managed by the Network is presented in Chapter 3. Klamath Network recognizes computer hardware and software can change at a rapid pace and data storage methodologies must be kept in line with the current technology. Data can easily become inaccessible to users if the data are stored using out-of-date software, unsupported hardware, or outmoded media. As software and hardware evolves datasets must be maintained and migrated to new platforms so they continue to be accessible. To keep data accessible, the Klamath Network will standardize on products required by the Department of Interior (DOI) agencies. In addition, the Network will store digital datasets in a format that is independent of a specific platform or software.
In general, the data the Klamath Network will maintain can be divided into short-term datasets and long-term datasets and their related components. Short-term data are usually associated with inventory data that is obtained over a few years (one to five years). Long-term datasets includes monitoring projects where data will be continuously acquired over a longer (five years or longer) timeframe.

10.1.1 Short-Term Datasets

Short-term datasets are expected to complete the data lifecycle within a five year time period. At the end of the project, it is the Data Manager's responsibility to make sure the project folder contains all necessary information including data, metadata, reports, publications, photographs, and the administrative documentation. As the Klamath Network changes versions of software, datasets will be migrated as needed to ensure accessibility to the end-users. No dataset will be stored in a software package more than two versions behind the current software version used by the Klamath Network.
At least one copy of all tables contained in a datasets will be store in a comma-delimited, American Standard Code for Information Interchange (ASCII) text file. The files will be accompanied with a text file that explains:

- Content of each file
- Relationships that may occur between tables
- Attribute definitions
- Associated documentation

Short-term datasets with associated documents and metadata will be maintained on the Klamath Network working directory in the file structure shown in section 3.2.2.

10.1.2 Long-Term Datasets

Long-term datasets will be divided into subsets of data based on the field season. Data gathered during a field season will be treated in a similar manner as a short-term dataset. It is the responsibility of the Project Manager to update the metadata during each field season. Once the data and metadata have undergone QA/QC processes by the Project Manger they will transfer the information to the Data Manager, who will merge the data into the project folder and associated programs. It is the Data Manager's duty to merge the seasonal data into the master database, maintain version control procedures for all documents and data, and store the data in the working and archive directories. Active long-term datasets will conform to the current NPS and I&M version standards.

10.1.3 Quality Assurances for Converted Data

ASCII files created for storage purposes will undergo a quality assurance process to ensure all data within a dataset have been correctly converted. Record counts and attribute structure will be examined to determine if data have been processed correctly. It is the Data Manager's responsibility to properly covert, document, and store the ASCII files. It will be the Project Manager's task to examine the data for completeness and to determine if the information has been thoroughly documented.

10.1.4 Spatial Data

It is the responsibility of the Project Manager to work with the GIS Specialist to complete FGDC-compliant metadata for all GIS layers created for a project. On a predetermined schedule, spatial layers and metadata will be transferred to the Data Manager for storage. It is the duty of the Data Manager to work with the Project Manager and GIS Specialist to maintain and update all GIS data.

Spatial data managed by the Klamath Network will be maintained and stored on databases servers utilizing Arc Spatial Database Engine (ArcSDE) and Oracle Database Enterprise. The server will consist of 13 drives with various RAID (redundant array of independent disk) configurations. The server infrastructure will be maintained by SOU while the data will be managed by the Network Data Manager in conjunction with the GIS Specialist. In addition, copies of spatial layers created from project data will be included in the GIS subfolder of the corresponding project folder.
As with short and long-term tabular datasets, no spatial data will be stored in a software package more than two versions behind the current software version used by the Klamath Network.

10.1.5 Digital Still Images

Images obtained to support a project should be collected in a Joint Photographic Experts Group (JPEG) format, if possible. The resolution and settings should be applied in a manner that produces an image of printable quality while still maintaining a reasonable file size.

We recognize that field crews may take numerous pictures that are not directly associated with the current project. Therefore, it is the responsibility of the Project Manager to

submit only project related photographs and an associated log to the Data Manager. Submitted photographs should adhere to protocols developed during the project's planning phase. In conjunction with the photographs, a log should be included listing the photograph name, date the photograph was obtained, and a brief description of the photograph. It is the Data Manager's responsibility to store and archive photographs following Klamath Network processes and procedures.

The Klamath Network is currently (as of 12/1/2005) in the process of developing an SOP for all photographs submitted to the Network that supports Klamath Network projects. The SOP will outline the process for collecting digital photographs, outline metadata that needs to accompany the photographs, and discuss procedures and databases used for photograph storage. Once complete, it will be the responsibility of the Project Manager to educate field crews on the methods associated with the SOP.

10.2 Physical Data

Physical data includes photographs, specimens, DVDs, CDs, datasheets, and notebooks. Ownership of the data, information, and products produced from a project will be clearly stated during the project's planning phase. For products being managed by the Klamath Network, we will work closely with park curators to determine the preservation process and location on a project-by-project basis. The Klamath Network will provide park curators with the necessary information to accurately catalog products. These data will be saved in a comma-delimited format (.csv) for automated uploading into ANCS+.

10.2.1 Specimens

Specimen archive locations will vary depending on the project and park. The Network Data Manager and Project Manager will work closely with park staff and NPS curators to determine the best location to store biological, aquatic, and botanical specimens. At no point will specimens be stored at the Network office unless proper storage facilities are provided.

10.2.2 Photographs

When applicable, the Klamath Network will follow the general guidelines in Conserve O Gram numbers 14/1 to 14/9 for photograph preservation. Some general guidelines in these documents include:

- Methods to mount photographs
- Storage enclosures for photographs and negatives
- General care and maintenance procedures for color and monochrome photographs

10.2.3 Datasheets

Hardcopy datasheets will be converted to an electronic copy (PDF) prior to storage. Datasheets will be stored in a locked file cabinet that is clean, dark, and dry. PDF documents will include the name of the project, Project Manager's last name, and the year of the field work in the title. File folders' naming convention should include:

- Project name
- Site name (if applicable)
- Year the data was collected

10.2.4 DVD and CD

The Klamath Network will follow the guidelines provided by Fred Byers in the NIST Special Publication 500-252 document entitled "Information Technology: Care and handling of CDs and DVDs – A Guide for Librarians and Archivists." Some of the general methods in this document include:

- Use a non-solvent-based permanent marker to mark the label side of the disk.
- Store disk upright in a clearly marked case.
- Return disk to storage case immediately after use.
- Store the disk in a cool, dry, dark environment.
- Use CD/DVD cleaning detergent, isopropyl alcohol, or methanol to remove dirt or materials.
- Do not touch the surface, bend the disk, or use adhesive labels.
- Do not expose disk to heat, humidity, or extreme temperature change.

10.3 Backup Processes

Proper storage of data needs to take into account the risk of data loss from a variety of natural and man-made causes including, but not limited to, fire, flood, user error, hardware and software corruption, vandalism, and security breach. The Klamath Network, in cooperation with SOU, will backup data on a nightly, weekly, and quarterly basis.

Nightly backups are done by SOU to store information that has been edited. This is not a full backup but is intended to protect documents that have been manipulated. This information is stored for a one week period before it is recycled.

SOU begins a weekly full backup of their servers on every Friday and stores the files on tape drives. The entire backup takes 25-30 hours to run, which includes all the SOU and Klamath Network data. Backups are stored for 60 days before the tapes are reused.

SOU will run quarterly backups on March 31st, June 30th, October 31st, and December 31st of each year. Files stored on a quarterly basis are maintained for one year before being recycled.

Backups are originally stored in a Scalar I500 tape library. Once backups are complete, the tapes are moved to a fire-safe room where they are stored for one week prior to being moved to a locking fire safe. The tapes are stored in the fire safe for an additional week and then moved off-site to a storage system maintained by Records Masters of Southern Oregon. After one year (quarterly backups) or two months (weekly backups) those tapes are returned to the University for recycling. It is the responsibility of each employee to

store all materials on the Klamath Network or GIS servers. Any material not on these servers will not be subject to SOU backup processes and may be lost.

10.4 Archiving and Storage

A data archive is a collection of datasets with related metadata, stored in a manner that they can be easily located, accessed, understood, and used. The archived data should be secure from natural and man-made disasters. In addition, the data and associated documents need to be stored and updated into a format that is accessible in an age of fast-paced technological change (Michener and Brunt 2000).

The Klamath Network stores data managed by the Network on a server that is maintained by SOU. It is the responsibility of all Klamath Network employees, and ultimately the Network Data Manager, to make sure data are stored in a manner that is complete and easy to retrieve. All requests for archived data should go through the Network Data Manager.

In addition, the Klamath Network will archive "project" data at the end of each field season or after a significant accomplishment has been added to the project folder. The archived data will be stored for a minimum of three years on the Klamath Network archive network drive located at the Data Manager's workstation.

10.5 Data and Network Security

Access to Klamath Network managed data is controlled by SOU using Novell Network and by setting up a Klamath Network "group" that defines various level of data access. It is the responsibility of the Data Manager to work with SOU IT personnel to manage the number of users. Currently, four SOU administrators and 11 personnel (Klamath Network/SOU) have access to the data.

Physical access to servers and storage tapes are limited to selected SOU IT personnel that are monitored by passwords and key cards. Backup tapes are transported in water-proof Pelican cases that are locked prior to leaving the storage safe.

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